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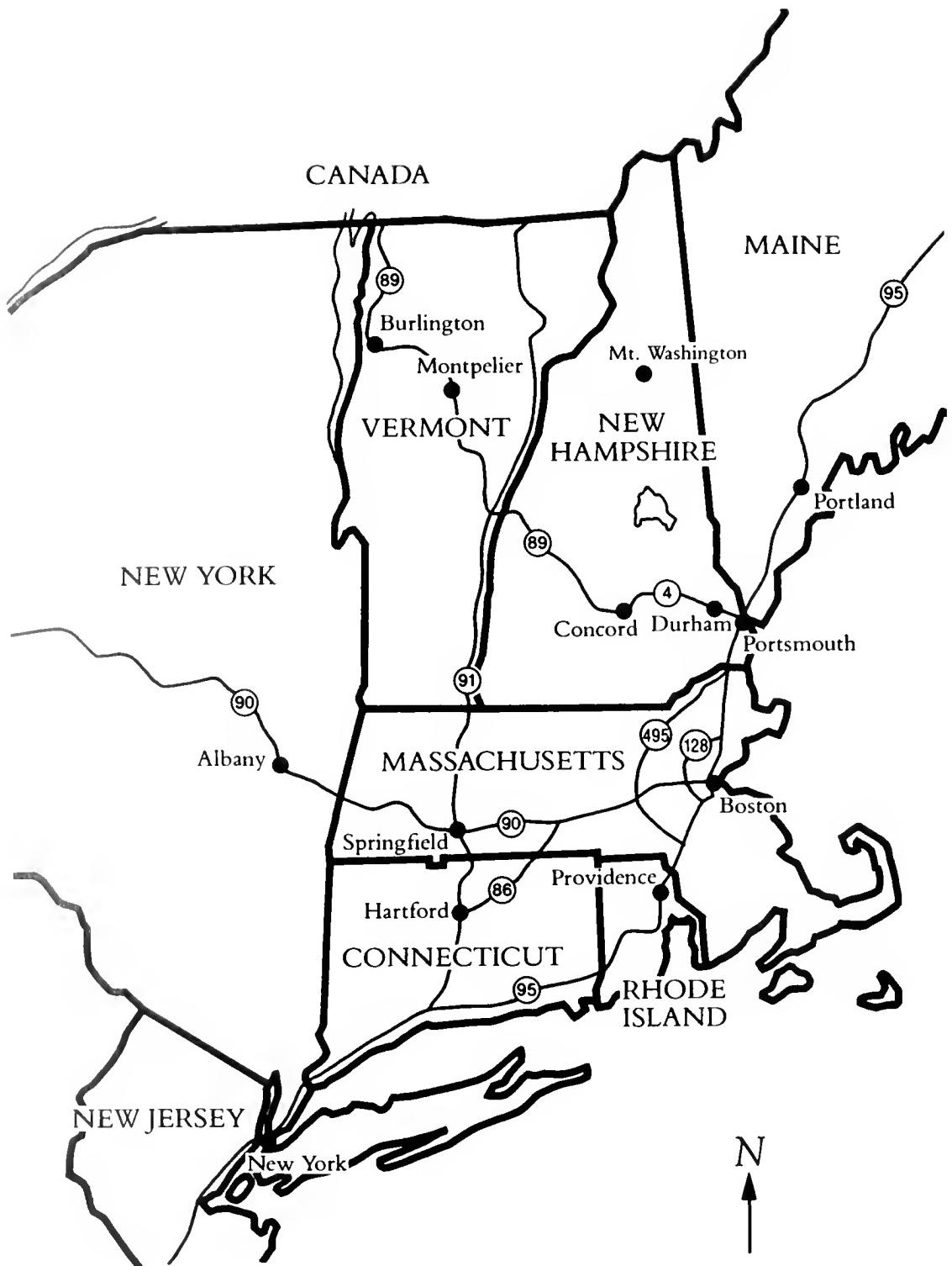
# Graduate Catalog

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# The Graduate School 1982-83

Map of New Hampshire	2	Call 278-772 N 5245 1982-83
Graduate Programs	3	
The University of New Hampshire and Graduate Education	5	
Research and Support Services	10	
Admission and Registration	12	
Fees and Financial Assistance	17	
Academic Regulations and Degree Requirements	21	
Departmental Requirements and Course Descriptions	27	
Trustees and Officers of the University	113	
Faculty of the Graduate School	114	
Campus Map and Key	126	
Graduate School Calendar 1982-83	128	
Index	130	

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# **Graduate Programs**

## ***Master of Arts***

Counseling  
Economics  
English  
    Literature  
    Language and Linguistics  
    Writing  
History  
Music  
Political Science  
Psychology  
Sociology  
Spanish

## ***Master of Science***

Animal Sciences  
Biochemistry  
Biology  
Botany  
Chemical Engineering  
Chemistry  
Civil Engineering  
Communication Disorders  
Computer Science  
Earth Sciences  
    Geology  
    Oceanography  
Electrical Engineering  
Entomology  
Genetics  
Home Economics  
Mathematics  
Mechanical Engineering  
Microbiology  
Music Education  
Natural and Environmental Resources  
    Forest Resources  
    Hydrology  
    Resource Economics  
    Soil Science  
    Resource Administration and Management  
    Wildlife Ecology  
Physical Education  
Physics  
Plant Science  
Zoology

## ***Master of Arts in Teaching***

Elementary Education  
Secondary Education

## ***Master of Science for Teachers***

Chemistry  
English  
Mathematics  
Physics

## ***Master of Education***

Administration and Supervision  
Counseling  
Developmental Disabilities  
Early Childhood  
    Special Needs  
Elementary Education  
Reading  
Secondary Education

## ***Master of Occupational Education***

## ***Master of Business Administration***

## ***Master of Public Administration***

## ***Certificate of Advanced Graduate Study***

Counseling  
Educational Administration and Supervision

## ***Doctor of Philosophy***

Biochemistry  
    Nutrition  
Botany  
Chemistry  
Earth Sciences  
    Geology  
    Oceanography  
Economics  
    Organizational Behavior/Labor  
Engineering  
    Signal Processing  
    Transport Phenomena  
    System Design  
    Theoretical and Applied Mechanics  
English  
Genetics  
History  
Mathematics  
Mathematics Education  
Microbiology  
Physics  
Plant Science  
Psychology  
Sociology  
Zoology



# **Graduate Education and the University of New Hampshire**

## **The University**

The home of the University is Durham—one of the oldest towns in northern New England. The town is semirural and still retains traces of its colonial past. Easy accessibility to Boston's cultural opportunities (65 miles to the south); the unsurpassed skiing, hiking, and scenery of the White Mountains (60 miles northwest); and the sandy beaches and rocky coast of New Hampshire and Maine (10 miles east) make it an ideal location.

The 188-acre campus is surrounded by more than 3,000 acres of fields, farms, and woodlands owned by the University. A 15-acre wooded tract, known as the Ravine, graces the center of the campus, allowing members of the University community some natural quiet midst the 35 classroom, research, and service buildings and 29 residential buildings of the campus.

The University is composed of the College of Liberal Arts, College of Life Sciences and Agriculture, College of Engineering and Physical Sciences, Whittemore School of Business and Economics, School of Health Studies, Thompson School of Applied Science, Division of Continuing Education, and the Graduate School. In addition to these colleges and schools located on the University campus, the University System of New Hampshire also includes Keene State, Plymouth State, and Merrimack Valley colleges and the School for Lifelong Learning.

The University enrolls more than 10,000 students, has a full-time faculty of more than 500, and offers 92 undergraduate and 66 graduate programs. The student body includes 1,000 graduate students.

The University of New Hampshire is a land-grant institution made possible by the Morrill Act of 1862, which aided states in developing institutions to serve all the people. The institution was founded as New Hampshire College of Agriculture and the Mechanic Arts in 1866 to train young men and women for service to the state through agriculture and technology. In 1893, New Hampshire College (as it was called at that time) moved from Hanover to Durham, as the result of a bequest of lands and funds by Benjamin Thompson, and began to develop more rapidly. University status was conferred in 1923. In 1980, UNH and the University of Maine were designated jointly as a Sea Grant College by the National Oceanographic and Atmospheric Administration (NOAA).

## **Graduate Education**

The University awarded its first Ph.D. in 1896, placing it among the first American universities to award that degree. Doctoral programs in their present form began in the 1950s.

Graduate education is supervised by a graduate faculty of more than 400. The Graduate School is led by the dean, who implements the policies of the graduate faculty. The Graduate Council is composed of elected faculty and student representatives and serves in an advisory capacity to the dean.

Quality graduate education requires development of new knowledge and communication of existing knowledge. The faculty, while dedicated to teaching, carry on an active research program, which supports graduate education by developing new knowledge and providing training opportunities for graduate students in residence. As a land-grant and Sea Grant institution, the University is responsible for conducting research and disseminating information to the public in areas affecting the nation's welfare.

The University of New Hampshire is the only university in the state, and is the primary institution within the University System of New Hampshire responsible for providing graduate programs that meet state and regional needs. Doctoral programs are offered exclusively on the University campus although other units of the University System offer some master's programs.

## **Master's Programs**

The University offers master's degree programs in a wide variety of disciplines. The master's degree can serve either as a professional terminal degree or as an intermediate degree for those intending to pursue further graduate study. Master's programs at the University of New Hampshire have been carefully developed and are reviewed by the graduate dean and faculty to ensure their continuing quality. In most programs, students can elect options that will permit them either to study one aspect of a discipline in depth by preparing a thesis or to gain a broader mastery of a discipline by electing to take course work in lieu of a thesis.

## **Doctoral Programs**

The University offers programs leading to the Doctor of Philosophy in those disciplines where it has both faculty and facilities to support advanced graduate education of high quality. Care has also been taken to ensure that the programs will make a significant contribution to the opportunities for doctoral education in the New England region. Doctoral education properly focuses upon preparing the student to contribute to the growth of knowledge through research. However, since a large percentage of doctoral students find employment in higher education, most doctoral programs provide opportunities for students to work as teaching assistants and to participate in seminars on teaching led by experienced faculty members. This preparation for the student's future role as both developer and communicator of knowledge has enabled recipients of the doctoral degree from the University of New Hampshire to obtain attractive teaching and research positions.

## **Interdisciplinary Programs**

The Graduate School encourages interdisciplinary study within its existing programs and has adopted procedures for faculty to develop interdisciplinary options within established doctoral programs. However, independent, self-designed graduate programs are not available at the University. Formal interdisciplinary degrees are offered in the Genetics Program, which involves geneticists from many departments in both master's and doctoral programs; the Engineering Ph.D. Program, which is a cooperative, interdisciplinary effort of the electrical and computer engineering, civil engineering, mechanical engineering, and chemical engineering departments; the Natural and Environmental Resources Program, which brings together resource economists, foresters, wildlife specialists, hydrologists, and soil scientists within the Institute of Natural and Environmental Resources (INER) to address the problems of our environment; and the Biology Program, which makes the resources of the biological science departments available to students interested in a general master's program. An option within the Biochemistry Ph.D. Program allows advanced study in nutrition, drawing upon the expertise of nutritionists from the departments of biochemistry, animal sciences, and home economics. Additional interdisciplinary opportunities are listed with the individual program descriptions.

## **The Graduate School**

The staff of the Graduate School is available to assist students in both academic and personal matters affecting their study at the University. Students are urged to contact the office with questions about academic policy, financial assistance and University services available to graduate students. The offices of the Graduate School are located in the Horton Social Science Center.

## **Graduate Student Life**

Graduate students play an active role in the life of the University community. In most departments, students are consulted concerning issues affecting their programs and serve as full voting members on important departmental committees. Three graduate students are elected by the graduate student organization as full voting members of the Graduate Council, the body that advises the graduate dean on all matters concerning Graduate School policy. Graduate students are also represented in the Academic Council of the Student Senate and Academic Senate and serve on such University-wide committees as the Research Council and the Teaching-Learning Council.

## **Recreational and Cultural Activities**

The University offers students a variety of recreational, social, and cultural opportunities. With two theaters and two art galleries in the Paul Creative Arts Center, the University is a major cultural resource for the entire state. The Sidore Lecture Series presents provocative, well-known speakers each year, while the University's Celebrity Series brings leading concert artists and professional talent to the campus. University students and faculty also perform in public concerts, recitals, and theater productions.

Approximately 100 student clubs and organizations are recognized on campus and membership in many of these is open to graduate students. Since graduate students are not required to pay the student activities fee, a nominal charge for admission to some events may be required.

The Memorial Union Building houses many of the student organizations and also provides lounges, eating facilities, and recreation areas for student use. New Hampshire's public television station, WENH-TV, also housed in the Memorial Union, broadcasts in-school programs for 110,000 young people and, during evening hours, cultural and educational programs.

Recreational facilities are also available at the field house for students who purchase recreation passes. The pass entitles the holder to use the athletic-recreation facilities during open recreation periods and to participate in certain club sports, noncredit instructional programs at reduced rates, and the faculty/staff/graduate student intramural program.

The University competes in 13 men's and 12 women's varsity athletic programs.

## **Graduate Student Residences**

**Babcock House:** The graduate residence hall is designed to provide housing for full-time graduate students and to provide quiet areas for graduate students to meet informally with one another and with members of the faculty. Babcock House is located on McDaniel Drive, within easy walking distance of a number of major classroom areas as well as the University Library, University theaters, and the Memorial Union Building. Parking is available on campus.

The structure, consisting of two six-story towers connected at each floor by a common lounge, accommodates 180 men and women. The house also has a large main lounge with fireplace, two recreation rooms, a food vending room, coin-operated laundry, TV room, luggage storage, individual mailboxes, and optional private room telephones. All rooms are single occupancy. Each room is furnished with a bed, mattress, easy chair, desk chair, and built-in desk-dresser-wardrobe unit with book shelves, mirror, medicine chest, and desk lamp. Residents provide their own bedding.

A full-time residence hall director lives in the apartment on the ground floor and works in conjunction with a graduate student House Council to provide cultural and social programs for the graduate community. The residence hall director and five graduate resident assistants carry out the administrative responsibilities of the house and are knowledgeable about University policies and available personal services.

The rental charge for Babcock House is \$1,374 per student per academic year. All rental fees are subject to revision by the Board of Trustees. Following acceptance to the Graduate School, a student will be contacted by the Office of Residential Life, Pettee House, University of New Hampshire, Durham, N.H. 03824.

**Forest Park Apartments:** The University owns and operates Forest Park, a complex of 154 studio (efficiency) and one- and two-bedroom apartments for students, faculty, and staff with families. The development is composed of two- and three-story buildings located on the edge of campus, convenient to all University facilities and within walking distance of the Durham shopping area and schools. Residency is not limited to graduate student families, and the demand for these apartments is great. To be eligible for the University apartments, a graduate student must have been admitted to the University and be a full-time student as defined in this catalog. Students may apply for Forest Park before fulfilling the above requirements as long as they are met at the time of assignment.

Since the waiting time can approach one year from date a student files an application until assignment, students should apply as early as possible. A brochure with the application blank and information about Forest Park is available from: Forest Park Resident Manager, Building 16, Forest Park, University of New Hampshire, Durham, N.H. 03824.

**Summer Housing:** Rooms in Babcock House are available to graduate students taking courses during the summer. Students interested in summer accommodations should contact the Summer Housing Office, Pettee House, University of New Hampshire, Durham, N.H. 03824 or complete and return the Summer Housing Application Form in the Summer Session Bulletin.

**Off-Campus Housing:** The Dean for Student Affairs office operates the Commuter/Transfer Center, which assists students in obtaining off-campus housing. As in most university communities, rents in the Durham area can be high and the supply limited. The office does have listings of off-campus rentals in Durham and the surrounding area that are updated weekly.

Students are encouraged to make every effort to come to campus so that the Commuter/Transfer Center staff will be able to assist in finding accommodations. The office is located in the Memorial Union Building and is open Monday through Friday.

**Dining:** Graduate students may elect to take their meals on a contractual basis with the University dining halls whether or not they live on campus. There are limited cooking facilities in Babcock House, but none in individual rooms. Information concerning meal

plans is available from the Office of Residential Life, Pettee House, University of New Hampshire, Durham, N.H. 03824.

### ***Health Services***

This service, located in Hood House, has a well-equipped clinic for diagnosis and treatment of student health problems. Services include: out- and in-patient care, laboratory tests, x-rays, limited mental health care, and routine medications. For serious medical problems, students are generally referred to consultants and/or a local hospital. An emergency ambulance service is available.

During the regular academic year, Hood House is staffed by full-time physicians, nurses, and part-time consultants. Regular clinic hours are held and appointments may be made upon request. Nurses are available 24 hours a day and a duty doctor is always on call.

Hood House operates on a limited basis during holidays, semester breaks, and summer session.

Full-time graduate students must pay the mandatory health fee. Part-time graduate students may be required to pay the health fee or pay a fee for services used (see fees, page 18). In addition, an optional group accident and sickness insurance policy is available through Hood House.

### ***Counseling***

The Counseling and Testing Center offers students, without charge, professional assistance in meeting a variety of personal, educational, and vocational problems. Services include individual and group counseling, vocational testing, and information on national testing programs such as the Graduate Record Examination and the Miller Analogies Test. Individual clinical testing is available.

The center sponsors a variety of student-oriented activities, e.g., personal skills groups on such topics as communication, values clarification, and life planning.

All information about students' visits to the Counseling and Testing Center is confidential and cannot be released without the permission of the student.

### ***Career Planning and Placement Service***

The Career Planning and Placement Service assists students in planning for professional careers following completion of their degree work. The assistance available to students includes an on-campus interview program, which brings recruiting personnel to the campus between November and May; a library of information on employers and career opportunities; career and life counseling; placement techniques workshops; and aid in finding summer employment.

The service will also update students' records and provide assistance to alumni.

### **Handicapped Student Services**

The Office for Handicapped Student Services assists disabled students with meeting their educational, cultural, and recreational needs while at UNH. The coordinator invites questions from students who are thinking of coming to UNH. For information, write to: Handicapped Student Services, Room 101, Huddleston Hall, University of New Hampshire, Durham, N.H. 03824.

### **Campus Minister and Churches**

A full-time, on-campus minister is funded by the Ecumenical Ministry to the University of New Hampshire. In addition, several denominations have designated chaplains. Places of worship for many faiths are convenient to the campus area. In Dover are a synagogue, Greek Orthodox Church, and a Friends Meeting; Protestant, Catholic, Episcopal, and Latter-day Saints churches are located in Durham.

### **The Alumni Association**

All recipients of a graduate degree from the University are considered members of the Alumni Association. It organizes alumni activities including educational, cultural, and social programs, both on and off campus. The *New Hampshire Alumnus* publishes news of alumni, the University, students, staff, and faculty.

### **The New England Center for Continuing Education**

The New England Center for Continuing Education is adjacent to campus. This architecturally striking complex was built with a gift from the Kellogg Foundation and is sponsored by the six New England state universities. The center provides residence and conference facilities for a wide variety of adult education programs. A closed-circuit TV system permits conference programs to be reviewed in participants' rooms.



# Research and Support Services

Research is an essential part of graduate education. It sustains a continuing infusion of knowledge, enhances the level of instruction, extends the frontiers of understanding, and makes human progress possible. It provides an opportunity for graduate students to learn by working with instructors on independent projects or as part of research teams. Ultimately, the goal is to share discoveries and applications with others in the state, region, and world.

## Research and Service Facilities

The University has many diversified research projects, ranging from highly specialized investigations in the physical and biological sciences to broad interdisciplinary marine studies. Graduate students are involved in research as project assistants working on research leading to master's theses and doctoral dissertations. These projects are conducted in individual departments, in University research centers, and in larger service units on campus.

The Marine Program, supported by the National Sea Grant College Program and state funding, has facilities both on campus and at the **Jackson Estuarine Laboratory**. The **Space Science Center** includes highly specialized facilities for faculty and graduate students to participate in sophisticated engineering and science research projects. Other specialized groups organized to facilitate interdisciplinary research are the **Family Research Laboratory**, **Marine Systems Engineering Laboratory**, and **Ocean Processes Analysis Laboratory**.

The recently established **University Instrumentation Center** coordinates the use of many highly specialized instruments and provides service to the many researchers on campus using instruments such as mass spectrometers, spectrophotometers, nuclear magnetic resonance spectrometers, amino acid analyzers, etc. The University Instrumentation Center has established a new electron microscope facility, which houses a transmission electron microscope and electron microprobe and a scanning electron microscope. The Instrumentation Center also provides technical support in the operation and maintenance of highly specialized equipment. A **Research Computer Center** has been established recently with the acquisition of a PRIME computer system.

The Agricultural Experiment Station, one of the largest research and service units at the University, provides research, information,

and testing for the state agricultural industry. The **Ritzman Animal Nutrition Laboratory** offers specialized research facilities.

## Marine Program

The University's central location on the northern New England coast near a variety of estuarine, coastal, insular, and continental-shelf environments has fostered a broad range of marine educational and research activities for many years. These varied activities, which occur within all of the University's colleges, are coordinated and supported by the Marine Program. Graduate degrees with marine options are offered in the departments of botany and plant pathology, chemical engineering, chemistry, civil engineering, earth sciences, electrical and computer engineering, mechanical engineering, microbiology, and zoology. Other departments involved with the Marine Program are animal science, biochemistry, computer science, mathematics, physical education, political science, and sociology and anthropology. The Institute of Natural and Environmental Resources, the Whittemore School of Business and Economics, and the Complex Systems Research Center are also involved with the Marine Program.

**Application for graduate study should be made to the department listed above which is most closely related to the applicant's interest.**

Marine research by faculty and students proceeds on both an intra- and interdisciplinary basis and is supported by University and private funds as well as by organizations such as the National Science Foundation, the Office of Naval Research, the National Institutes of Health, the U.S. Coast Guard, the Woods Hole Oceanographic Institution, and the National Sea Grant Program. UNH and the University of Maine together are a Sea Grant College.

Marine research activities are principally pursued in the neighboring environments of the Great Bay estuarine system, the coastal zone, the near-shore coastal zone, the Isles of Shoals, and the Gulf of Maine, but also in the more remote areas of the world such as the North Sea and the Arctic, Antarctic, and mid-Pacific oceans. Some examples of research studies include those relating to marine food chains; marine biotoxins; trace metals; biological and thermal pollution; marine mineral resources; mariculture; marine resource management; marine law; environmental base-line studies; arctic under-ice systems; diving systems; submersibles; and buoy systems and breakwaters.

The Marine Program building houses work spaces for ocean engineering, physical sciences, and other marine activities, as well as the Marine Program Office. The Marine Systems Engineering Laboratory and Ocean Process Analysis Laboratory serve faculty and students from the four engineering departments and others associated with activities supporting projects and applied research in the marine environment. The Jackson Estuarine Laboratory, located on Great Bay about five miles from the campus and fourteen miles from the ocean via the Piscataqua River, supports the research of the marine life sciences and earth sciences departments. Research vessels dock at an adjacent pier. The Diamond Island Ocean Engineering Station, located about 40 miles from Durham on Diamond Island in Lake Winnipesaukee, furnishes an excellent fresh-water testing site for ocean systems. A running-seawater facility at Fort Stark in Newcastle, near Portsmouth, is nearing completion. The Shoals Marine Laboratory, located about seven miles off the New Hampshire coast on Appledore Island of the Isles of Shoals, a joint facility of UNH and Cornell, is principally concerned with marine life sciences educational and research activities. A near-coast pier facility, situated about ten miles from Durham in Portsmouth, New Hampshire, and two miles from the ocean on the Piscataqua River, serves research vessels up to approximately 50 feet in length and commercial fishing boats of the area. The R/V *Jere Chase* is a 45-foot research vessel equipped for a wide variety of marine research activities in the estuarine and near-coast waters.

## Library

The University Library houses more than 800,000 volumes, more than 6,000 periodicals, and substantial microfilm and audio-tape and record collections. Specialized subject collections are housed in four branches: chemistry in Parsons Hall, engineering and mathematics in Kingsbury Hall, biological sciences in Kendall Hall, and physics in DeMeritt Hall. The branches are administered by a physical sciences librarian and a biological sciences librarian. Media Services, a department of the library, offers a large film collection, equipment loans including projectors and portable TV cameras and monitors, photographic and graphic design assistance, and audiovisual project consultation.

Special services offered to graduate students include graduate study areas, with assignable locked book trucks. Graduate students may use the Interlibrary Loan System to supple-

ment material available in the University Library. The library is a U.S. government document depository, and a full-time documents librarian is available. On-line data base search services are offered at cost through the Reference and Branch Departments.

The library serves the University and the town of Durham. A graduate student's spouse and children may use the facilities, which include a professionally staffed children's room.

During the regular academic year, the library is open seven days a week. On vacations and during the summer, a more limited schedule is in effect.

## Computer Services

The University of New Hampshire has one of the largest and most accessible computer installations of its type in the country. UNH Computer Services operates several large computers (two DEC 10s, two VAX 11/780s, two PRIMES) in support of the combined instructional, research, and administrative data processing needs of the University.

More than 200 terminals are tied into the UNH computer, with three major clusters in classroom buildings and one in a residence hall. Each cluster is staffed by a consultant. Other terminals are located in Dimond Library and dormitories. In addition, the departments of mathematics, computer science, and electrical and computer engineering have their own mini- and micro-computers and computer labs for course and research use.

A Research Computing Group channels its collective energies and expertise into the support and promotion of research activities on the Durham campus. In addition to providing high-level consulting to researchers, the group also engages in program investigation and acquisition, and exploration and evaluation of network links; members are familiar with mini- and micro-computer systems as they relate to the needs of researchers on campus.

Short, noncredit courses are regularly offered, at nominal charge, to users of the facilities. Extensive on-line system documentation is supplemented by a physical library with a collection of manuals, technical publications, trade journals, and textbooks.

Publications of Computer Services include a newsletter, *On-Line*, and other specialized instructional materials.

# Admission and Registration

## Admissions

### General Requirements

Persons holding the baccalaureate degree from a college or university of approved standing and wishing to take graduate level courses at the University as part of a graduate degree program must apply for admission to the Graduate School. Admission to the Graduate School is both limited and competitive and is based solely upon academic qualifications and potential.

Application procedures are outlined below and are included with the application materials available at the Graduate School. Specific program information and requirements are outlined in the program descriptions of this catalog. The completed application for admission to graduate study also serves as the application for new students for assistantships, fellowships, and full-time scholarships supported by the Graduate School.

Applicants to programs leading to the Master of Science for Teachers degree must meet, in addition to the normal requirements, one of the following admission requirements: 1) completion of education courses sufficient for certification, 2) three years of teaching experience, or 3) a current full-time teaching position.

Applicants may apply to only one specific degree program.

### Application Procedures

Application materials may be requested from the Graduate School, University of New Hampshire, Horton Social Science Center, Durham, N.H. 03824.

#### Applicants for admission must:

1. Submit the official application form in duplicate. An application file is not started until the application form is received.
2. Submit a \$15 nonrefundable application fee.
3. Request that two official transcripts from each college/university attended be sent directly to the Graduate School.
4. Request that three recommendations using official recommendation forms be sent directly to the Graduate School. Letters of recommendation more than 12 months old are not acceptable. (Placement credentials more than one year old may be accepted as one letter of recommendation.)
5. Request the official test scores (GRE, GMAT), if required, be sent by the Educational Testing Service directly to the Graduate School. Test scores more than five years old may not be acceptable.

6. Submit any additional material required by individual programs.

7. Submit the Statement of Residence Form (New Hampshire residents only).

Applications will not be reviewed until they are complete. It is the applicant's responsibility to make sure that the required application materials have been submitted by the appropriate deadline.

**All application material becomes part of the permanent records of the University of New Hampshire and will not be returned.** Access to this material is limited under the Family Rights and Privacy Act of 1974. Applicants who are not admitted, or who are admitted and do not register in the Graduate School, do not have access to their application file. Material received as part of the application process will not be duplicated for personal use by the applicant nor forwarded to a third party. Materials received from applicants who do not complete their application, who are not admitted, or who are admitted and do not register are held for one year before being destroyed.

### Applicants from Foreign Countries

All applicants from nonEnglish speaking countries must, in addition to all of the above, provide TOEFL (Test of English as a Foreign Language) scores. A minimum TOEFL score of 550 is required. TOEFL test scores are valid for only two years. A financial statement on official University forms is also required.

Applications from residents of foreign countries will be considered only for regular admission.

### Application Deadlines

Applications must be completed by December 1, 1982, for the spring session 1983; by April 1, 1983, for the summer session 1983; and July 1, 1983, for the fall session 1983. There is no guarantee that applications completed after these deadlines can be acted upon in time to permit registration in the desired session.

Applicants for financial assistance (assistantships, fellowships, scholarships) should complete their application prior to February 15, 1983, to insure consideration for the 1983-84 academic year.

Foreign applicants who are not currently residing in the United States will normally be considered only for admission for the fall session (1983) and must have their application completed by April 1, 1983. Foreign applicants currently residing in the United States

should have their application completed at least four months prior to the session for which they are applying.

Programs that consider applications only for a specific session are noted on the "Instructions for Application for Admission to Graduate Study," included with the application materials.

**Incomplete Applications:** Applications that remain incomplete after the first day of classes of the semester for which admission was desired will be placed in an inactive status. A written request is required to reactivate an application.

### ***Application Review***

Once an application is complete, it is reviewed by faculty members of the appropriate program. All material that is submitted as part of the application receives careful consideration. The review is normally conducted by an admissions committee of graduate faculty members, which makes recommendations to the Graduate School concerning the admission of applicants to the program. Upon receipt of the committee's recommendation, the Graduate School carefully reviews the applicant's file. After making the final decision, the Graduate School will inform all applicants of the

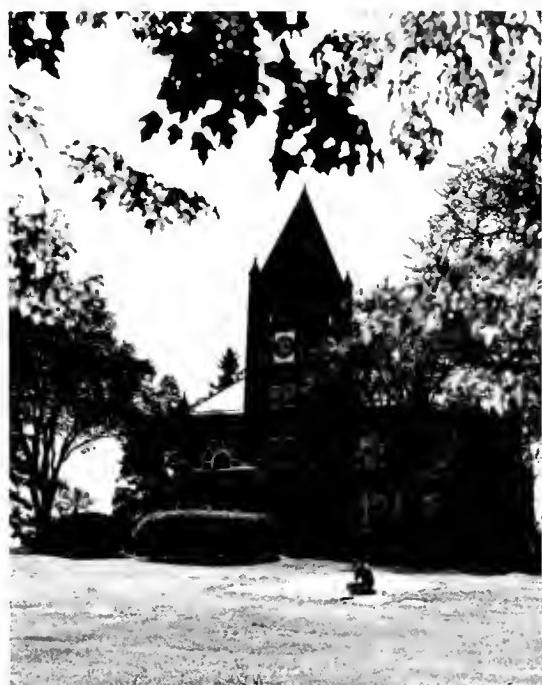
action taken. While applicants with bachelor's degrees may apply directly to certain doctoral programs, the Graduate School reserves the right to offer these applicants admission at the master's degree level.

### ***Admission Categories***

Official offers of admission from the Graduate School are made for a specific term and year in one of the following categories:

**Regular Admission:** Regular admission may be offered to those applicants whose academic records and supporting documents indicate that they are fully qualified to undertake graduate study in their chosen field.

**Provisional Admission:** Provisional admission may be offered to applicants whose academic records and supporting documents indicate that they are qualified to undertake graduate study, but whose undergraduate preparation was not in the intended field of graduate study. Applicants offered provisional admission must meet the specific criteria, usually undergraduate coursework, stated at the time of their admission before being admitted to regular graduate-student status.



**Conditional Admission:** Conditional admission may be offered to those applicants whose academic records indicate deficiencies but suggest some promise of success in graduate study. Students offered conditional admission must meet the specific requirements stated at the time of their admission before the conditional status will be removed. Students on condition are not eligible for assistantships, fellowships, and scholarships offered through the Graduate School.

Offers of admission, regular, provisional, or conditional, to applicants who are in the final year of an undergraduate, or, in some cases, a graduate-degree, program are contingent upon the successful completion of that degree program. An official final transcript showing grades and the awarding of the degree must be received by the Graduate School prior to enrolling for the graduate program.

Applicants who cannot enroll in the term for which admission was offered may request to have their **admission deferred** for up to one year. Such requests must be in writing and will be considered only once. Because enrollments are limited and competition for admission may vary from year to year, such requests may not be granted.

### ***Additional Information***

**Early Admission—University of New Hampshire Seniors:** Qualified senior students at the University of New Hampshire may be admitted to the Graduate School provided they have followed normal application procedures; they must have been admitted for the semester in which they wish to enroll in courses for graduate credit. A 3.2 cumulative grade point average is normally required to be considered for early admission. Such seniors are normally admitted prior to the start of their last undergraduate semester. Seniors who have been admitted under early admission may register for a maximum of two courses for graduate credit (see also dual credit on page 22).

**Admission to the 3/2 Program:** Undergraduate UNH students may be admitted to one of the approved five-year combined bachelor's degree/Master of Business Administration (see undergraduate catalog) programs, which normally commence during the fall semester of their senior year. Application to the Graduate School is made during the second semester of the junior year. Interested students should contact the assistant dean in the Whittemore School for information.

**Special Students:** Individuals holding baccalaureate degrees may register for graduate courses on campus through the Division of Continuing Education in Verrette House, or for graduate courses off campus through the School for Lifelong Learning. These individuals are designated as "special students," and are not required to file an application for admission to the Graduate School and are not candidates for a graduate degree. Special students are not normally permitted to register as full-time students. (see nine-credit rule on page 22).

**University of New Hampshire Employees:** Members of the University of New Hampshire faculty with the rank of assistant professor or above will not be admitted to the graduate programs. Full-time staff employees of the University who do not hold academic rank will not ordinarily be admitted to doctoral programs in the department in which they are employed. The above regulations pertain even to individuals who resign their positions.

**Honorary Fellows:** Qualified scholars who may temporarily desire the privilege of using the library and research facilities of the University and who are not candidates for a degree may, upon recommendation of the Dean of the Graduate School and the approval of the president of the University, be appointed honorary fellows without stipend. Honorary fellows shall not be required to pay any charges except the cost of unusually expensive supplies or equipment.

**Applicants Not Admitted:** Applicants who are denied admission may have their applications reconsidered only if they furnish significant additional material that was not available at the time of the original decision, such as evidence of further academic achievement, or more recent and significantly improved GRE or GMAT scores. Reapplication is not encouraged.

## **Registration**

### ***Academic Year***

Students admitted to the Graduate School must have their programs approved by their adviser or the chairperson of their guidance committee. Registration is held the first Monday after classes begin each semester. All tuition and fees are payable at the time of registration. Registration information and the *Time and Room Schedule* may be obtained from

the Registrar's Office, Thompson Hall. Admitted students may not register through the Division of Continuing Education during the academic year.

**Continuous Registration:** Students who are in residence and using University facilities are required to register each semester. **Master's students** who have completed all course requirements and have previously registered for the maximum number of thesis or project credits and are on campus completing their master's program must register for Master's Continuing Enrollment. **Doctoral students** who are in residence and have completed all course requirements must register for Doctoral Research 999 each semester even if the minimum requirement (two semesters) has been met.

**Full-time Students:** Graduate students registered for nine or more credits, Master's Continuing Enrollment, or Doctoral Research 999 are classified as full-time students. Students holding appointments as graduate assistants or project assistants are also considered full-time and must register for a minimum of six credits, Master's Continuing Enrollment, or doctoral research each semester.

**Maximum Load:** The maximum graduate load allowed is 16 credits (12 credits for a student on an assistantship). Only under unusual circumstances will a student be allowed to exceed these limits, and then only with the recommendation of the student's adviser and the approval of the Dean of the Graduate School.

**Dropping and Adding Courses:** Graduate students may add or drop courses in accordance with the procedures and deadlines published by the Registrar's Office in the *Time and Room Schedule*. Deadlines are also published in the calendar on page 128 of this catalog.

**Auditing Courses:** A graduate student may, with the approval of his or her adviser and the faculty member concerned, audit any course at the University. The deadline for requesting an audit is Friday of the second week of classes. Subsequent requests for change to audit must be petitioned and be approved by the course faculty member, the student's adviser, and the Dean of the Graduate School.

**Change of Address:** It is the responsibility of the student to complete a change of address form in the Office of the Registrar whenever

a change is made in the local, campus, and/or mailing address.

### **Summer Session**

Although many graduate level courses are offered during the Summer Session, the University does not guarantee that any particular course will be offered. The availability of individual faculty members to supervise research or to participate in qualifying examinations and final examinations or defenses during the Summer Session varies from year to year.

Course information and registration materials may be obtained from the Division of Continuing Education, Verrette House.

Deadlines for completion of degree requirements for the 1983 Summer Session are listed on page 129 of this catalog.

**Maximum Load:** The maximum graduate load allowed is four credits for a four-week summer session and eight credits for an eight-week summer session. Only under unusual circumstances will a student be allowed to exceed these limits, and then only with the recommendation of the student's adviser and the approval of the Dean of the Graduate School.

### **Nonregistration**

**Leave of Absence:** Students who find it necessary to interrupt their graduate programs may request a leave of absence by writing to the Dean of the Graduate School stating the reasons for, and the anticipated length of, the interruption. Leaves are granted for a specific time, usually not to exceed one calendar year. Students who are on approved leaves of absence must notify the Graduate School at least four weeks prior to the start of classes for the term in which graduate work is to be resumed. Students who do not return from a leave of absence as approved will have their degree status discontinued and will be required to apply for readmission.

**Withdrawal:** A student may withdraw from the Graduate School during any semester by obtaining a withdrawal form from the registrar or the Graduate School. This form should be signed by the student's adviser, the Dean of the Graduate School, and other appropriate University officials. When completed, the form should be filed with the registrar. Students who formally withdraw are required to apply for readmission if they subsequently desire to resume their academic program.

**Degree Status Discontinued:** Students who do not formally withdraw and do not register during a twelve-month period or do not return from an approved leave of absence are considered inactive and will have their degree status discontinued. Students are notified by the Graduate School when this administrative action is taken and are required to apply for readmission if they subsequently desire to resume their academic program.

**Administrative Withdrawal for Reasons of Health and Procedures for Readmission:** The Dean of the Graduate School, in consultation with professional University Health Services officials, may temporarily suspend a graduate student from the University without prejudice for reasons of seriously impaired physical or mental health and/or in consideration of the physical health, safety, and well-being of members of the University community. Such action shall be taken only for bona fide health and safety emergencies and should not be used as a means of excluding qualified handicapped students.

The dean or designee shall provide the student with a written statement of the reasons for the temporary suspension. The student may request a hearing with the dean or designee to dispute the reasons. The student may be represented at the hearing by a member of the University community. If the student fails to request such a hearing within ten days of beginning the temporary suspension, or if the temporary suspension is upheld at the hearing, the temporary suspension shall be changed to an administrative withdrawal.

Readmission is contingent upon receipt by the directors of counseling and/or health services, or their agents, of a medical release from a licensed attending medical authority; an evaluation by University Health Services; and a personal interview with the Dean of the Graduate School, who, on the basis of the information received, will either approve or disapprove the application.

**Readmission:** Students who withdraw or who have their degree status discontinued are required to apply for readmission. Readmission forms are available at the Graduate School and must be processed at least four weeks prior to the start of classes for the term in which readmission is sought. Students are not guaranteed readmission.

## Change of Degree

An enrolled student who wishes to pursue a degree program other than the one for which admission was granted originally should file an application for a change in degree with the Graduate School. Change of degree requests should be filed by the regular admission deadlines listed on page 128. The Dean of the Graduate School will notify the student of the decision after consulting with the appropriate departments.

Students enrolled in UNH master's programs who intend to pursue the Ph.D. in the same department in which they were admitted for the master's degree should submit to the Dean of the Graduate School an application for a change in degree program. This application will be reviewed by the Graduate School, which will notify the student of the decision. If such students do not file a change-in-degree application before receiving the master's degree, they will be required to submit a new application for admission to study for the Ph.D. degree.

# Fees and Financial Assistance

## Fees

Tuition and fees vary according to whether or not the student is a legal resident of the state of New Hampshire and/or is enrolled full or part time. All charges are payable at the time of registration.

### New Hampshire Residents

Each graduate student is classified as a resident or nonresident for tuition purposes at the time of admission to the University. The decision, made by the Graduate School, is based upon information furnished by the student's application and any other relevant information.

All applicants living in New Hampshire are required to submit a notarized statement to the effect that they have been legally domiciled in New Hampshire continuously for at least 12 months immediately prior to registering for the term for which in-state status is claimed.

Students admitted from states other than New Hampshire or from foreign countries are considered nonresident throughout their entire attendance at the University unless they shall have acquired bona fide domicile in New Hampshire. Changes in residency will only occur if the student can clearly establish that his or her residence in New Hampshire is for some purpose other than the temporary one of obtaining an education at the University.

The burden of proof in all cases is upon the applicant. In all cases, the University reserves the right to make the final decision as to resident status for tuition purposes. The University Rules Governing Tuition Rates are fully set forth in the application for admission package; all students are bound by them.

### New England Regional Program

The University of New Hampshire participates in the New England Regional Student Program administered by the New England Board of Higher Education. Under this program, admitted graduate students from New England may qualify for regional tuition rates (New Hampshire resident tuition, plus 25 percent) if the program to which they are admitted is one which is not available at their home state university. Inquiries and requests for further information may be directed to the Dean of the Graduate School, Horton Social Science Center, UNH, Durham, NH 03824 or to the New England Board of Higher Education, Center School, School Street, Wenham, MA 01984.

### Sub-Degree Exchange Program

The Graduate School of the University of New Hampshire participates in a Sub-Degree Exchange Program sponsored by the New

England Land Grant Universities. The program is designed to provide any admitted student at one of the six land-grant universities access to the full range of talent and resources available in the region. Under the agreement, graduate students may, with the approval of the Dean of the Graduate School at UNH and the graduate dean of the host university, take advantage of courses or other special resources not available at UNH. Specific information about the program may be obtained from the Dean of the Graduate School, Horton Social Science Center, UNH, Durham, NH 03824.

### Tuition Waiver for Senior Citizens

Any New Hampshire resident senior citizen who submits evidence of being 65 years of age or over, and whose participation is not intended for economic improvement, will be allowed to take courses at UNH with the tuition waived. Such waivers shall cover the cost of tuition only, and are limited to a maximum of eight academic credits per semester for each eligible individual. Admission into particular courses will be granted on a space-available basis, at the discretion of the graduate dean. All other costs of attendance are to be borne by the student.



## Schedule of Fees

The following schedule of fees is in effect each semester of the 1982-83 academic year. Required, nonrefundable fees for all students include a Memorial Union fee, which funds the personnel, programs, and maintenance of this building; a Student Services fee, which partially funds the programs and services available in the Division of Student Affairs, including Handicapped Student Services and the Commuter/Transfer Center; and a health fee, which partially funds Health Services. The services and facilities are available to all—the extent to which each student uses them cannot be the factor by which assessment is determined.

	Full-time (9-16 credits)	Part-time (5-8 credits)	Part-time (1-4 credits)
<b>Tuition:</b>			
NH Resident	875.00	75.00/cr hr	75.00/cr hr
Nonresident	2425.00	210.00/cr hr	210.00/cr hr
Doctoral Research	300.00	—	—
Master's Continuing Enrollment	150.00	—	—
<b>Mandatory Fees*:</b>			
Memorial Union	25.00	12.50	—
Student Services	8.75	4.35	—
Health Fee	34.00	17.00	—
<b>Registration Fee:</b>			
NH Resident	—	5.00	5.00
Nonresident	—	10.00	10.00

\*Students on assistantships, fellowships, or full-time tuition scholarships, students registered for doctoral research (999), and students registered for Master's Continuing Enrollment are considered full-time and are required to pay full mandatory fees.

**The University reserves the right to revise its schedule of tuition and fees without notice.**

**Master's Continuing Enrollment:** Master's students in residence and registered for Master's Continuing Enrollment will pay \$150 tuition plus full mandatory fees per semester during the academic year and \$75 plus fees per summer session.

**Doctoral Research:** Doctoral students in residence and registered for Doctoral Research 999 will pay \$300 plus full mandatory fees per semester during the academic year and \$150 plus fees per summer session. Students who register for coursework in addition to doctoral research will pay the appropriate additional tuition charges up to the appropriate maximum tuition rate for full-time students.

Tuition and fees are payable at registration and a student is not considered registered until they have been paid.

The above charges will apply to admitted graduate students enrolling for courses at the University during the academic year. Admitted graduate students planning to enroll for

courses through the School for Lifelong Learning or during the summer session should consult the relevant catalogs for information regarding tuition and fees.

## Other Charges and Fees

**More Than 16 Credits per Semester:** Graduate students are charged full tuition at the appropriate rate plus the appropriate course charge for each credit beyond 16 if registered for more than 16 credits 30 days after the semester has begun. (No refund will be made if students subsequently drop a course lowering their load to 16 or fewer credits.)

**Zero Credit Seminars:** Seminars for zero credit are assessed as if they were for one credit.

**Audit:** Charges for auditing a course are the same as those for taking it for credit.

**In-Absentia Fees:** Students who are not registered at the time they complete their degree requirements (examinations, submission of thesis, dissertation, etc.) will be assessed an in-absentia charge one month prior to the conferral of their degrees. The in-absentia charge is \$25 for master's candidates; \$25 for C.A.G.S. candidates; and \$100 for doctoral candidates.

**Late Fees:** A \$10 fee is charged for **each course dropped** after the second Friday of classes. A \$10 fee will also be assessed for **each course added** after the third Friday of classes. This includes a **\$10 per course charge** for persons who register after the third week of classes. A change of section (within the same course) is accomplished by a "drop" of one section and an "add" of another section. The fee will not be assessed for the add portion of a late section change; but the \$10 drop fee will still apply for the drop portion of the late section change.

## Refunds

Tuition during the academic year is refundable in accordance with the calendar published in the *Time and Room Schedule* and the calendar on page 128 of this catalog. The mandatory health fee may be refunded upon petition to Hood House. (Students must petition for refund no later than two weeks after graduate registration. Forms are available in the Health Services Office at Hood House. Refund requests should be sent directly to Health Services, Hood House.) The Memorial Union fee, the Student Services fee, and the Energy Surcharge fee are nonrefundable.

# **Financial Assistance**

## **General Information**

There are several forms of financial assistance available to graduate students most of which are awarded for an academic year commencing in September. To be eligible for any assistance, the student must first be admitted to the Graduate School. The Graduate School normally administers and awards the fellowship and scholarship programs. Assistantships and associateships are normally awarded by the individual graduate programs. Loans and work-study programs are administered by the Financial Aid Office. The application for admission with supporting documents serves as the application for new graduate students for the fellowship, scholarship, and assistantship programs available to them and should be completed by February 15 for the following academic year. Separate application forms are required for the loan and work-study programs administered by the Financial Aid Office and are available at that office in Thompson Hall. The deadline for receipt of these applications is May 1.

## **Fellowships and Scholarships**

**University of New Hampshire Fellowships:** A limited number of three-year "University of New Hampshire Fellowships" are awarded to outstanding doctoral students. Each recipient is given an opportunity to spend the first year in full-time study, the second year as a teaching assistant, and the third year as a research assistant. The stipends for this program are \$4,200 for the first academic year, \$4,400 for the second academic year, and \$4,600 for the third academic year. In addition, the award provides \$1,000 support for each of two summers and waiver of tuition. These awards are made by the Graduate School Student Fellowship Selection Committee from nominations from the various programs.

**Graduate Scholarships for Merit:** A recipient of a graduate assistantship or a project assistantship who is newly admitted to a Ph.D. program and has outstanding qualifications may be awarded a Graduate Scholarship for Merit. The scholarship will supplement the stipend to provide a total level of academic year support of \$4,800-\$5,100. Continuation of a Graduate Scholarship for Merit into succeeding years will be contingent upon the student's demonstration of superior performance in a doctoral program.

**Full Tuition Scholarships:** Up to 55 superior students may be granted academic-year

tuition scholarships. These awards provide only for waiver of tuition charges and are subject to the maintenance of a high scholastic record in the Graduate School. Application is made to the student's department.

**Part-time Tuition Scholarships:** Up to 25 superior students may be granted part-time tuition scholarships. These awards provide a waiver of tuition charges of \$300 and are awarded each semester. Applications are available at the Graduate School Office. University employees or family members who are eligible for staff benefits are not eligible to receive part-time tuition scholarships.

**Dissertation Fellowships:** Dissertation Fellowships with stipends of up to \$4,600 for a maximum tenure of one academic year are available. These awards include a waiver of the doctoral research registration fee for the period of the award. Applications should be made to the Dean of the Graduate School.

**Martin Luther King Assistantships:** Martin Luther King Assistantships provide support for qualified members of minority groups. A letter of application should be made to the Dean of the Graduate School.

**Summer Fellowships for Teaching Assistants:** A limited number of Summer Fellowships are available for students who have held graduate assistantships involving teaching during a previous academic year. The stipend for summer study is \$1,000.

## **Assistantships**

Approximately 380 graduate and project assistantships are awarded annually to superior students. Appointments are for one academic year. An appointment may be renewed provided that funds are available and that the student's academic performance, as well as performance in carrying out the responsibilities of the assistantship, is satisfactory. Students normally are involved in assistantship activities for 20 hours a week. All graduate students holding appointments as graduate or project assistants must be admitted on a regular or provisional basis to the Graduate School and must register for a minimum of six credits (maximum of 12 credits), or Master's Continuing Enrollment, or doctoral research during each semester in which they hold their appointments. Such students are considered full-time students. A limited number of newly admitted doctoral students who are awarded assistantships may also receive a Graduate Scholarship for Merit as explained above.

**Inquiries regarding assistantships should be addressed to the chairperson or director of graduate studies of the appropriate department or program.**

Appointments are made in the following categories:

**Graduate Assistants:** Most assistants are involved in assisting faculty members in instructional activities. A limited number of appointments involve assisting in research activities in the Agricultural Experiment Station. Stipends for graduate assistants are \$4,200 for the 1982-83 academic year (\$4,500 for assistants in chemistry, physics, and engineering). Doctoral students who have held an assistantship for two years may qualify for a stipend of \$4,600 per academic year. University-supported graduate assistants receiving the full academic-year stipend may be exempted from the payment of tuition during the academic year of their appointment and the following summer session. University-supported graduate assistants receiving half the normal academic-year stipend may be exempted from the payment of half of their tuition in the academic year of their appointment and the following summer session.

**Project Assistants:** These assistants aid faculty members in externally funded research projects. Stipends for graduate assistants are \$4,200 for the 1982-83 academic year (\$4,500 for assistants in chemistry, physics, and engineering). Doctoral students who have held an assistantship for two years may qualify for a stipend of \$4,600 per academic year. Project assistants receiving the full academic-year stipend may be exempted from the payment of tuition during the academic year of their appointment. Project assistants receiving half the normal academic-year stipend may be exempted from the payment of half of their tuition in the academic year of their appointment.

**Graduate Associates:** A very limited number of highly qualified graduate students may be appointed to teaching or research positions as graduate associates. The academic load for students appointed to these positions will not exceed two full courses or doctoral research registration per semester. Stipends are negotiable up to \$7,000 per academic year according to the qualifications and duties of the student. Graduate associates receiving a stipend of more than \$3,000 per academic year may be exempted from the payment of tuition during the academic year of their appoint-

ment. Graduate associates receiving \$3,000 or less per academic year may be exempted from the payment of half of their tuition during the academic year of their appointment.

**Summer Assistantships:** Full-time summer employment may be available for project assistants or graduate assistants. The monthly rate for full-time employment for graduate assistants ranges from \$930 to \$1,020. Students are normally employed for a maximum of two months and are not normally permitted to register for summer session courses.

### ***Loan and Work-Study Programs***

**National Direct Student Loans:** To be eligible for consideration, a student must be an admitted degree candidate carrying at least one-half the full-time academic load as defined by the University, be a U.S. citizen or a permanent resident of the U.S., and establish need for a loan that is to be used for educational purposes only.

**UNH Loans:** To be eligible for consideration, a student must be a registered degree candidate. Financial need must be clearly established, and if approved, the loan may be used for educational purposes only. The maximum amount granted to a student is \$1,000 during his or her undergraduate and/or graduate work.

**College Work-Study Program:** With the aid of federal funds, the University is able to provide employment opportunities on campus or in various off-campus agencies. To be eligible for consideration, a student must be an admitted degree candidate carrying at least one-half the full-time academic load as defined by the University and demonstrate financial need as determined by the Financial Aid Office. Work during the academic year is usually on campus.

**Application material for the above programs may be obtained from the Financial Aid Office, Thompson Hall. A May 1 priority deadline is in effect.**

**Guaranteed Student Loan Programs:** Students may apply for as much as \$5,000 per year from a bank or other financial institution participating in the Guaranteed Student Loan Program. Qualified borrowers pay no interest while attending college. Repayment of principal and interest begins nine months after the student ceases a full-time course of study. Check with your local bank for further details and current interest charges.

# Academic Regulations and Degree Requirements

It is the responsibility of the student to become familiar with the academic regulations and degree requirements of the Graduate School as well as the special requirements of his or her own academic program.

## Academic Regulations

Graduate credits may be earned in courses numbered from 700 through 898 and in Master's Thesis 899 and Doctoral Research 999. The faculty of each graduate program prescribes the courses that make up the degree program. In addition, the Graduate School has general requirements for master's and doctoral degree programs.

**800-level courses:** are offered for graduate credit **only** and therefore are **only open** to admitted or special graduate students.

**700-level courses:** are advanced-level undergraduate courses and may be taken for graduate credit.

**600-level courses:** are advanced-level undergraduate courses, which may be taken for graduate credit under limited conditions by degree candidates only, provided the courses are given in a department other than the one in which the degree is earned and are approved by the Dean of the Graduate School. Courses taken off campus at the 600 level will not be approved for graduate credit.

Graduate credits will not be given for any 600- or 700-level courses that are open to or have freshmen or sophomores enrolled.

### Grades

The following grades are used at the University: A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F. Graduate credit is normally granted only for coursework completed with a grade of B- or higher. Individual programs may have stricter requirements for major courses. Grade points and averages are not calculated for graduate students.

**AF Grades:** An "AF" grade, Administrative F, is assigned for failure to either drop or complete the course. An AF is considered a failing grade by the Graduate School.

**C, C+ Grades:** The Dean of the Graduate School may, under limited conditions, approve up to eight credits of C or C+ grades for graduate credit. When a student's advisory committee or a student's adviser, in conjunction with the appropriate departmental com-

mittee, wishes to recommend that credit be given for work completed with a C or C+, the advisory committee shall forward its recommendation, with appropriate justification, to the Dean of the Graduate School within one month after conclusion of the course. Normally these courses will be in elective courses outside the student's major area.

**Credit/Fail Grades:** A "CR" grade is given for complete, approved theses and dissertations, as well as other approved courses and seminars.

With the permission of the instructor at the time of registration, a graduate student may elect to take independent study courses on a credit/fail basis. Students electing this option should ask the instructor to send written notification to the Graduate School and Registrar's Office that the graduate student is taking the course credit/fail. The undergraduate pass/fail option is not available to graduate students.

**Audit Grades:** An "AU" grade is assigned for completion of courses for which audit approval was granted. No credit is earned.

**Incomplete Grades:** An "IC" grade is assigned with the approval of the instructor **only** for excused unfinished work. The work must be completed and submitted to the instructor by the last day of classes of the semester immediately following the one in which the incomplete was granted. A petition requesting an extension of time, approved by the instructor, may be submitted to the Dean of the Graduate School by the last day of classes. An extension will be granted by the dean only under unusual circumstances. An incomplete grade automatically becomes an F if not removed or a petition for an extension approved within the allowed time period. This policy also applies to students who withdraw from the University or who are not currently registered.

An "IA" grade is assigned for approved continuing courses such as thesis or doctoral research and remains on the record until the course requirements are completed.

**W Grades:** If a student withdraws from school or drops a course prior to mid-semester, the course(s) will not appear on the student's permanent record. If a student withdraws from school, or for compelling nonacademic reasons, submits an approved petition to drop a course after mid-semester, a notation of "W" will be shown on the

student's academic record, together with the grade in the course at the time the course is dropped.

## **Academic Standards**

Any graduate student receiving failing grades in nine or more credits will be dismissed from the Graduate School. Any grade below the B- level, including grades of C or C+ which may have been approved for graduate credit, will, for the purposes of determining academic standing, be considered failing grades. Failing grades (below B-) received in undergraduate courses taken while the student is in the Graduate School are counted in the cumulative total of failing credits. Students are advised that this academic standing requirement is the minimum standard required by the Graduate School.

Each individual program may set and announce standards for coursework and research achievement that are more rigorous than this minimum standard. Thus, students in some programs may be dismissed if they accumulate less than nine credits of failing grades and/or fail to make adequate progress in other aspects of their graduate program.

## **Dual Credit**

**UNH Seniors:** University of New Hampshire seniors who have been admitted to the Graduate School under early admission (see page 14) may, upon recommendation of the department and approval of the Graduate School, be allowed, for a maximum of two 800-level courses, to count credits toward both a bachelor's and master's degree. Dual credit forms must be completed and approved by the Dean of the Graduate School at the beginning of the semester for which dual credit is sought. Dual credit forms are available at the Graduate School.

## **Transfer Credit**

Candidates for the master's degree and the Certificate of Advanced Graduate Study (C.A.G.S.) may request that up to six semester credit hours earned at another institution, which is regionally accredited at the graduate level, be transferred to count toward a master's program or C.A.G.S. All courses presented for transfer must have been completed with a grade of B or better and must have been taken for graduate credit; courses cannot be transferred for credit if already applied in whole or in part toward another degree. Transfer of credits must be recommended by the program faculty and approved by the Dean of the Graduate School. Students taking

courses at another university for transfer after enrolling at UNH should obtain approval of their adviser and the graduate dean prior to enrolling for the course. Since the doctoral degree does not require a specific number of courses, credits are not normally transferred onto doctoral students' academic records.

## **Special Student Credits**

**Nine-Credit Rule:** A maximum of nine credits earned in University of New Hampshire graduate courses by a special student may, upon recommendation of the program faculty and approval of the Dean of the Graduate School, be applied to a student's degree program. The nine-credit limitation applies to all courses completed or in process on the date when the official letter of admission is written.

## **Off-Campus Courses**

Credits earned off campus will be applied toward a graduate degree only if recommended by the major department and approved by the Graduate School. UNH courses offered off campus that are not listed in the *Graduate Catalog* or specifically approved by the Dean of the Graduate School will not be approved for graduate credit.

**12-Credit Rule:** A maximum of 12 credits, not including thesis, may be earned in UNH courses taken off the Durham campus. Credits earned off campus by a special graduate student will be counted as part of the 12 credits. Credits transferred from another university will also count as a part of the 12 credits allowed.

**Exceptions to the 12-Credit Rule:** Students who are admitted to external graduate degree programs (currently the Executive MBA program) are exempt from the 12-credit rule.

Students who are admitted to all other graduate degree programs are subject to the 12-credit rule. Exceptions for these students may be granted on a course-by-course basis. Courses taught by regular members of the graduate faculty of UNH may be approved for exception to the 12-credit rule. The Graduate School maintains a list of the approved courses. It is the responsibility of students who have reached the 12-credit maximum to check with their adviser to see if the desired course(s) can be applied toward their degree program, and with the Graduate School to see if the course has been approved for exception to the 12-credit rule.

# Master's Degree Requirements

## General

**Credits:** A minimum of 30 graduate credits is required for all master's degrees. Many programs require substantially more than the minimum 30 credits. Individual program requirements are outlined in the program descriptions of this catalog. Graduate credits are normally earned in courses numbered 700-899. Master's candidates must earn at least eight credits in courses numbered 800-898 (Thesis credits cannot be used to meet this requirement). Up to four credits earned in courses numbered 600-699 may be taken for graduate credit by master's degree candidates provided the courses are approved by the Dean of the Graduate School and given in a department other than the one in which the degree is earned.

**Residency:** A student will normally spend at least one calendar year, or the equivalent, in satisfying the requirements for the degree.

**Master's Continuing Enrollment:** Master's students who have completed all course requirements and have previously registered for the maximum number of thesis or project credits and are on campus completing their master's program must register for Master's Continuing Enrollment.

**Time Limit:** All graduate work for any master's degree must be completed within six years of the time of registration for the first graduate work applied toward the degree (including special and transfer credits). Progress toward the degree will be carefully monitored by the adviser and the Graduate School to ensure that adequate advancement is made toward the completion of the program and that any deficiencies noted at the time of admission are removed.

## Nonthesis Option

Students who are in a nonthesis program may be required to pass a final examination. This examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examination for the master's degree. The time of final examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date at which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the Dean of the Graduate School.

**Examining Committee:** Examining committees, when required, are appointed by the Dean of the Graduate School, upon recommendation of the department or program concerned. Normally three members are required. The Dean of the Graduate School is an ex officio member of all examining committees.

## Thesis Option

Students who are in a thesis program are required to conduct independent research and prepare a scholarly paper for submission to the Graduate School. Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed. Students writing a thesis should obtain a copy of the *Thesis and Dissertation Manual* from the Graduate School. Students who are in a thesis program may also be required to pass a final examination. The regulations concerning this exam are the same as those in the nonthesis option above. The thesis committee will normally also serve as the examining committee.

**Thesis Credits:** A minimum of 6 and a maximum of 10 thesis credits may be applied toward a master's degree. The exact number of credits to be applied toward the degree will be determined by the faculty of the individual programs. No thesis credit shall be given until the completed thesis has been approved by the thesis committee. Satisfactory acceptance of the thesis will be recorded as a credit (Cr).

**Thesis Committee:** A master's thesis must be approved by a committee composed of the faculty member under whose direction it was written and two other members of the graduate faculty nominated by the department chairperson and appointed by the Dean of the Graduate School.

**Submission of Thesis:** Two copies of the approved thesis, ready for binding, shall be submitted to the Graduate School Office as soon after approval as possible, but not less than two weeks before Commencement. Binding fees will be paid at the Graduate School. Most programs require an additional one copy of the thesis.

# Certificate of Advanced Graduate Study

## Requirements

Requirements for completion of the Certificate of Advanced Graduate Study are found under the program descriptions in Education, on page 54.

## Doctoral Degree Requirements

### General

The degree of Doctor of Philosophy is conferred on qualified candidates who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed an oral examination in defense of the dissertation. The degree of Doctor of Philosophy is essentially a research degree. It is not given merely for the completion of course credits.

**Credits:** There is no specific number of courses required for the Ph.D.

**Residency:** All doctoral students must be registered each semester that they use University facilities. A minimum of three academic years of graduate study is required for the doctorate. Resident graduate work done at other universities may be counted toward the minimum requirement upon approval of the guidance committee and the Dean of the Graduate School, but one full academic year must be in residence at the University of New Hampshire. In individual cases, the major department and the Dean of the Graduate School may grant permission to pursue the research for the dissertation at another institution where access to special facilities would be advantageous.

**Doctoral Research:** A minimum of two semesters of registration in doctoral research is required. However, doctoral students using University facilities while engaging in dissertation research must register for 999 each semester, even if the minimum requirement has been met.

**Guidance Committee:** A guidance committee will be appointed by the Dean of the Graduate School upon the recommendation of the program faculty as soon as possible after a student has begun study for the doctoral degree. The committee will have the responsibility of assisting the student in outlining a

program and preparing for the qualifying examination, and will administer the examination.

**Qualifying Examination:** The qualifying examination is required and may be written, oral, or both. This examination will test: 1) the student's general knowledge in the student's major and minor work and 2) the student's fitness for engaging in research, particularly in the subject proposed for the dissertation. The results of the examination will be communicated by the chairperson of the student's program to the Dean of the Graduate School.

**Language/Research Tool Requirement:** Each doctoral program has its own language and/or research tool requirements. These requirements can be found in the individual program descriptions.

**Degree Candidacy:** A doctoral student is advanced to candidacy for the degree by the Dean of the Graduate School after the student has passed the qualifying examination, met the language or proficiency requirements as are deemed desirable by the student's program, and declared a topic for dissertation research.

**Doctoral Committee:** After the student has been advanced to candidacy, a doctoral committee will be appointed to supervise and pass on the dissertation and administer the final examination. This committee will be nominated by the department of major concentration and appointed by the Dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments. The Dean of the Graduate School is an ex officio member of all doctoral committees.

**Time Limit:** All graduate work for the doctorate must be completed within eight years of the beginning of doctoral study, unless the student entered with a master's degree in the same field, in which case the doctorate must be completed within seven years. The beginning of doctoral study is defined as the beginning date of the earliest course applied to the doctoral record. The student must be advanced to candidacy within five years of the beginning of doctoral study, or within four years if the student entered with a master's degree in the same field.



**Dissertation:** The dissertation must be a contribution to scholarship in the student's discipline, embodying the results of significant and original research, and a mature and competent piece of writing. Students writing dissertations should obtain a copy of the *Thesis and Dissertation Manual* from the Graduate School.

**Final Defense:** A copy of the completed dissertation must be made available to the members of the examining committee two weeks before the final examination date.

The final oral examination is conducted by the doctoral committee and is intended to give the candidate an opportunity to defend the dissertation. A written final examination, on subject matter not covered in the qualifying examination, may also be required. This written examination is conducted by the major department. These final examinations must be completed by the date listed in the calendar on page 128. After consultation with the major department, the dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate's performance by a majority vote.

**Submission of Dissertation:** As soon after the examination as possible, but not less than two weeks prior to Commencement, two co-

pies of the approved dissertation, ready for binding, shall be turned in to the Graduate School Office. Binding, microfilming, and copyright fees will be paid at the Graduate School. Most departments require an additional one copy of the dissertation. Students should consult their advisers concerning dissertation requirements.

Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. Students are urged to protect their research by copyrighting their dissertation at the time of microfilming. If the material presented in the dissertation is published, it should be designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

## Graduation

Students are required to file an "Intent to Graduate Card" with the Registrar's Office at the beginning of the semester in which they intend to graduate. Specific information concerning graduation is available at the Graduate School or the Registrar's Office in Thompson Hall.

Students should be aware that all coursework taken prior to the official awarding of the degree will apply only to that degree program.

Deadlines for 1982-83 graduation are listed in the calendar on page 128.



# Departmental Requirements and Course Descriptions

## Key

When two course numbers precede a course title and are connected by a hyphen, the first semester of the course, or its equivalent, is a prerequisite to the second semester. If the course numbers are separated by a comma, qualified students may take the second semester without having had the first.

The notation "Lab" indicates that laboratory sessions are a part of the course.

Each prerequisite for a course is separated from the other prerequisites by a semicolon; e.g., Prereq: Educ 807; Psyc 841. If permission (of the instructor, department, adviser, or committee) is a prerequisite for all students, it is listed among the prerequisites: e.g., Prereq: Educ 807; Psyc 841; permission. If, on the other hand, permission may be substituted for one or more of the listed prerequisites, it follows the other prerequisites and is separated from them by a slash mark: e.g., Prereq: Educ 807; Psyc 841; /or permission. If permission may be substituted for only one of the prerequisite courses, it is listed with the course for which it may be substituted: e.g., Prereq: Educ 807 or permission; Psyc 841.

Cr/F following the description indicates that no letter grade is given but that the course is graded credit/fail.

For up-to-date information about when a course is offered; who teaches the course; the number of recitations, lectures, labs, and such, students are referred to each semester's *Time and Room Schedule*, which carries a complete schedule of courses for the semester.

## Department Abbreviations

The following department abbreviations are used. An asterisk indicates those disciplines in which graduate programs are offered.

### College of Liberal Arts

Anth	Anthropology
Arts	Arts
*Biol	Biology
Clas	Classics
*Educ	Education
*Engl	English
Fren	French
Geog	Geography
Germ	German
Grek	Greek
*Hist	History
Huma	Humanities
Ital	Italian
Latn	Latin
Ling	Linguistics Program
*Micr	Microbiology
*Musi	Music
*MuEd	Music Education
Phil	Philosophy
*Polt	Political Science
*Psyc	Psychology
RS	Religious Studies

Russ	Russian
ScSc	Social Science
S S	Social Service
*Soc	Sociology
*Span	Spanish
ThCo	Theater and Communication
W S	Women's Studies
*Zool	Zoology

### College of Life Sciences and Agriculture

*AnSc	Animal Sciences
*Bchm	Biochemistry
*Bot	Botany and Plant Pathology
CD	Community Development
*Ento	Entomology
*FoRs	Forest Resources (INER)
*HEc	Home Economics
*Hydr	Hydrology (INER)
*INER	Institute of Nat. & Envir. Resources (INER)
*OcEd	Occupational Education
*PiSc	Plant Science
*REco	Resource Economics (INER)
*Soil	Soil Science (INER)

### College of Engineering and Physical Sciences

*Ch E	Chemical Engineering
*Chem	Chemistry
*Ci E	Civil Engineering
*C S	Computer Science
*ESci	Earth Science
*E E	Electrical and Computer Engineering
E T	Engineering Technology
*Math	Mathematics
*M E	Mechanical Engineering
*Phys	Physics
*Engr	Ph.D. Engineering
Tech	Technology nondepartmental

### School of Health Studies

*Comm	Communication Disorders
HAP	Health Administration and Planning
MedT	Medical Technology
Nurs	Nursing
OT	Occupational Therapy
*PhEd	Physical Education
RecP	Recreation and Parks
SHS	School of Health Studies

### Whittemore School of Business and Economics

*Admn	Administration
*Econ	Economics
Hotl	Hotel Administration
Secr	Secretarial Studies

### Separate Departments and Programs

Aero	Aerospace Studies
DCE	Division of Continuing Education (all courses)
*Gen	Genetics Program
Inco	Intercollege
Milt	Military Science
SLL	School for Lifelong Learning
TSAS	Thompson School of Applied Science

## **Animal Sciences (AnSc)**

**Chairperson:** Thomas P. Fairchild

**PROFESSORS:** Walter M. Collins; Thomas P. Fairchild; James B. Holter; Samuel C. Smith; Richard G. Strout

**ASSOCIATE PROFESSORS:** William A.

Condon; Walter E. Hylton; Charles G. Schwab

**ASSISTANT PROFESSORS:** William E.

Berndtson; Roger A. Cady; Ginny W. Darr;

Alan H. Parsons; Roger E. Wells

An applicant admitted to graduate study in animal sciences is expected to have had sufficient undergraduate training in the basic biological sciences to qualify for special work in this field.

Students pursuing the Master of Science degree in animal sciences may select courses in genetics, nutrition, physiology, management, and diseases and parasites. A thesis is required, and a candidate for the master's degree shall register for six thesis credits and pass an oral examination covering the graduate courses and thesis. A minimum of two Animal Sciences seminars is also required.

Doctoral-level study in areas related to animal sciences is offered through other biological science departments. Specifically, an interdisciplinary option is offered by the departments of Biochemistry and Animal Sciences leading to the Ph.D. degree in Biochemistry (Nutrition); and the Ph.D. degree is offered in genetics through an Interdepartmental Genetics Program (see Genetics Program in this catalog).

Opportunities are provided for students to obtain teaching as well as research experience during their graduate studies.

### **701. PHYSIOLOGY OF REPRODUCTION**

Comparative aspects of embryology, anatomy, endocrinology, and physiology of reproduction. Mr. Condon. Lab. 4 cr.

### **702. EXPERIMENTAL**

### **ENDOCRINOLOGY OF REPRODUCTION**

Discussions of current research literature plus application of laboratory techniques to the study of hormone relationships in the reproductive system. Prereq: AnSc 701 and permission. Mr. Condon. Lab. 4 cr.

### **704. PRINCIPLES OF PATHOBIOLOGY**

Principles of disease processes; reactivity of the diseased cell, tissue, and organ. Prereq: animal anatomy, health, and disease courses; /or permission. Staff. 3 cr.

### **709. BIOCHEMISTRY OF NUTRITION**

Intermediary metabolism of nutrients and energy; metabolism transport mechanisms; biological oxidation; interrelationships of carbohydrate, fat, and protein metabolism; obesity; control of hunger and appetite. Mr. Parsons. Prereq: college course in biochemistry. (Also offered as HEC 709.) 4 cr.

### **710. ANIMAL NUTRITION**

Feeding and related management of farm animals with special emphasis on dairy cattle; nutrients and their use, digestive anatomy and physiology, energy systems, forage systems and quality, ration balancing (dairy, beef, sheep, poultry, swine, and equine), and selected metabolic disorders. Prereq: principles of nutrition or permission. Mr. Holter. 4 cr.

### **711. COMPARATIVE ANIMAL GENETICS**

How heredity affects domestic animals, poultry, other mammals, and fish; emphasis on the organism and population. Quantitative inheritance; principles of selection; disease resistance; statistical and experimental techniques. Prereq: 4 cr. of genetics; /or permission. Mr. Collins. Lab. 4 cr.

### **712. ANIMAL BREEDING AND IMPROVEMENT**

Principles of selection and breeding systems as they apply to the genetic improvement of dairy cattle, livestock, and horses. Prereq: AnSc 711 or permission. Mr. Cady. Lab. 4 cr. (Not offered every year.)

### **714. INTRODUCTION TO ELECTRON MICROSCOPY**

Principles, theory, and methods used in preparing and examining vertebrate tissues in the transmission and scanning electron microscopes; interpretation of electron micrographs. Prereq: chemistry; permission. Ms. Darr. 3 cr.

### **715. INTRODUCTION TO ELECTRON MICROSCOPY LAB**

Application of principles and theories presented in 714. Students carry out fixation embedding ultra microtomy, critical point drying operation of transmission and scanning electron microscopes, and photographic procedures. Coreq: intro to electron microscopy. Prereq: permission. Ms. Darr. 2 cr.

### **795-796. INVESTIGATIONS IN DAIRY, LIVESTOCK, POULTRY**

A) Genetics: Mr. Collins, Mr. Fairchild; B) Nutrition: Mr. Holter, Mr. Schwab, Mr. Parsons; C) Management; D) Diseases: Mr. Hylton, Mr. Strout, Mr. S.C. Smith, Ms. Darr; E) Products; F) Light Horses: Mr. Berndtson; G) Physiology: Mr. Condon, Mr. Berndtson; H) Cell Biology: Ms. Darr, Mr. Strout. The student may select a special problem in any of the fields listed under the guidance of the instructor. Prereq: permission. May be repeated. 1-4 cr.

### **801. ADVANCED STUDIES IN ANIMAL BREEDING**

Independent study and research on modern breeding methods and newer systems of selection for quantitative traits. Prereq: AnSc 712. Mr. Collins, Mr. Fairchild. Hours to be arranged. 3 cr.

### **802. MEATS, LIVESTOCK MARKETS, AND PRODUCTS**

The essential factors in meat selection, cutting, curing, and smoking; study and discussion relative to the problems of livestock marketing and the procedure in the large central markets. Trips are taken to various packing plants. Lab. 4 cr.

### **803. ENERGY METABOLISM AND NUTRITION**

Incidental lectures, assigned reading, and laboratory practice in methods of research with major emphasis on protein and energy metabolism. Mr. Holter. 3 cr. (Not offered every year.)

**804. PROTEIN METABOLISM AND NUTRITION**

Metabolism of dietary amino acids in the mammalian system with emphasis on various aspects of protein nutrition. Prereq: permission. Mr. Schwab. (Also offered as HEc 804.) 4 cr. (Not offered every year.)

**805-806. AVIAN MICROBIOLOGY**

The disease process (acute or chronic) in the intact host at cellular levels when invaded by viruses or virus-like agents, fungi, and protozoans. Physiological and cytopathological changes in tissue culture. Mr. Strout. 3 cr.

**807-808. AVIAN HISTOPATHOLOGY**

First semester: general histopathology. Second semester: the special histopathology of common diseases with emphasis on correlation of light and electron microscopy of tumors and tumor formation. Prereq: histology or the equivalent. Mr. Strout. 3 cr.

**810. MINERALS AND VITAMINS IN NUTRITION**

Metabolism and function of mineral elements and vitamins in higher animals. Prereq: permission. Mr. Parsons. (Also offered as HEc 810.) 4 cr. (Not offered every year.)

**812. QUANTITATIVE GENETICS AND SELECTION**

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Prereq: one course each in genetics and statistics. Mr. Collins. 3 cr. (Not offered every year.)

**851. CELL CULTURE**

Theory; principles fundamental to the culture of cells in vitro. Introduction to techniques of preparation and maintenance of animal, plant, insect, and fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prereq: gen micro; permission. Mr. Strout and Mr. Minocha. Lab. 4 cr. (Also offered as Micr 851 and Bot 851.)

**853. ADVANCED CELL BIOLOGY**

A study of the ultrastructure and function of cell organelles followed by an analysis of various specialized animal cells to show how differences in form and location of various organelles lead to differences in function. Prereq: biochemistry; physiology; vertebrate anatomy; /or permission. Ms. Darr. 4 cr. (Not offered every year.)

**895-896. RESEARCH IN ANIMAL SCIENCES**

Advanced investigations in a research project, exclusive of thesis project. Elective only after consultation with the instructor. May be repeated. 1-4 cr.

**897, 898. ANIMAL SCIENCE SEMINAR**

A survey of recent literature and research in the animal sciences. Staff. (May be repeated.) 1 cr. Cr/F.

**899. MASTER'S THESIS**

Hours to be arranged. 6-10 cr.

**Biochemistry (Bchm)**

**Chairperson:** James A. Stewart

**PROFESSORS:** Donald M. Green; Edward J. Herbst; Miyoshi Ikawa; Samuel C. Smith; James A. Stewart

An applicant who gains admission to graduate study in biochemistry is expected to have completed basic courses in chemistry, biological sciences, mathematics, and physics. Otherwise well-qualified applicants will be permitted to correct deficiencies in undergraduate education by enrollment in the appropriate courses or by independent study.

The department offers opportunities for specialization in developmental biochemistry, biochemistry of natural products, physical biochemistry, biochemical genetics, and structure and metabolism of macromolecules. Opportunities also exist for interdisciplinary research specialization in marine biochemistry, biochemical nutrition, and cell biology in adjunct facilities on campus. In addition to the graduate courses in biochemistry, courses in advanced organic chemistry, radiochemistry, advanced microbiology, and genetics are usually recommended.

Participation of all graduate students will be required in the instructional activities of the department, either in the laboratory, in lectures, or in an individual instruction format. These teaching assignments are an essential part of the graduate academic programs of the department and are designed to give graduate students practical teaching experience. Normally one year of part-time teaching will be required of each student.

**Master of Science** degree candidates will be expected to develop a thesis on a basic research problem or to prepare a report or publication based on an applied project in biochemistry. All candidates for the M.S. degree will be required to pass an oral examination based on the thesis or project report and on the graduate courses completed in the degree program.

**Doctor of Philosophy** degree candidates will be required to complete a dissertation on original research in biochemistry. At the end of the first year of graduate study, a preliminary examination on organic chemistry, physical chemistry, and general biochemistry will be presented to students in the doctoral program. The results of this examination and the student's academic record will be evaluated at this time to ascertain eligibility to proceed to candidacy in the doctoral program. Upon completion of graduate courses recommended by a guidance committee and demonstration of proficiency in the translation of biochemical literature in either German, French, or Russian, a doctoral student will be required to pass an oral qualifying examination conducted by the guidance committee. The successful completion of these requirements and advancement to candidacy for the Ph.D. degree must occur at least six months prior to the final oral defense of the Ph.D. dissertation administered by the student's doctoral committee.

**702. COMPARATIVE MARINE BIOCHEMISTRY**

Nutrition, metabolism, and composition of marine organisms and relation to phylogeny; marine natural products. Mr. Ikawa. Prereq: general biochem or equivalent. 3 cr. (Alternate years; offered 1983-84.)

### **721. NEUROCHEMISTRY**

Biochemistry of the nervous system; metabolism and alterations of normal brain chemistry by drugs, chemicals, nutrition, memory, and learning; pathological changes. Mr. Stewart. Prereq: a biochemistry course. 3 cr. (Alternate years; offered 1982-83.)

### **751-752. PRINCIPLES OF BIOCHEMISTRY**

Fundamental biochemistry; chemistry, metabolism, and biological function of nucleic acids, proteins, carbohydrates, and lipids. Prereq: organic chemistry; or permission. Mr. Stewart. Lab. 4 cr.

### **760. ENZYME CHEMISTRY**

Structure, properties, and function of enzymes; kinetics and mechanisms of enzyme-catalyzed reactions; purification, characterization, and assay of enzymes. Prereq: general biochem or 751. Lab. 4 cr. (Alternate years; offered 1982-83.)

### **771. BIOCHEMICAL GENETICS**

Mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: Bchm 751; or permission. Mr. Green. 3 cr.

### **772. INTRODUCTORY LABORATORY IN MOLECULAR GENETIC TECHNIQUES**

Modern biochemical gene manipulation techniques including the genetic, physical and enzymatic characterization of gene vectors, gene cloning, construction of genetic probes, and sequencing of nucleic acids. Mr. Green. Prereq: Bchm 751-752 and Bchm 771, Bchm 781, or Micro 804. 2 cr.

### **781. THE NUCLEIC ACIDS**

Chemistry and metabolism of nucleic acids; molecular structures, purification and separation, biosynthesis, and biological functions. Mr. Herbst. Prereq: organic chemistry; biochemistry. 3 cr.

### **789. SPECIAL TOPICS IN BIOCHEMISTRY**

Seminars by guest speakers in selected areas of biochemistry. 2 cr. Cr/F. (Not offered every year.)

### **795, 796. INVESTIGATIONS IN BIOCHEMISTRY**

Subject matter and hours to be arranged. Prereq: permission. 2 cr.

### **811. BIOCHEMISTRY OF LIPIDS**

Chemistry, metabolism, and function of lipids. Prereq: Bchm 752 or equivalent. Mr. Smith. 3 cr. (Alternate years; offered 1982-83.)

### **832. BIOCHEMISTRY OF CARBOHYDRATES**

Chemistry, metabolism, and functions of carbohydrates. Polysaccharides, glycoproteins, and the nature of cell surfaces. Prereq: general biochem or equivalent. Mr. Ikawa. 3 cr. (Alternate years; offered 1982-83.)

### **842. BIOCHEMICAL REGULATORY MECHANISMS**

Nonreplicative functions of DNA; transcription and translational control of protein synthesis; quantitative regulation of proteins; regulation of metabolism by hormones, allosteric regulation and repression; regulatory mechanisms operating during development and differentiation. Prereq: a course in biochemistry. Mr. Stewart. 3 cr. (Alternate years; offered 1983-84.)

### **850. PHYSICAL BIOCHEMISTRY**

Structure, interactions, and physical properties of biomolecules. Thermodynamic, hydrodynamic, and spectroscopic methods for study of proteins and nucleic acids. Prereq: physical chemistry and biochemistry. 3 cr. (Alternate years; offered 1983-84.)

### **897, 898. BIOCHEMISTRY SEMINAR**

Prereq: permission. 1 cr.

### **899. MASTER'S THESIS**

To be arranged. 6-10 cr.

### **999. DOCTORAL RESEARCH**

## **Biology: Intercollge Biological Sciences Organization**

**Chairperson:** Robert A. Croker

**Chairperson of Graduate Advising Committee:** Philip J. Sawyer

The Master of Science program in biology is administered by the Intercollge Biological Sciences Organization, which is composed of faculty members involved in teaching and research in various biological sciences. Students in the program consult with the Graduate Advising Committee in planning their individual programs. At present, participating faculty are drawn from the following areas: molecular, cellular, and developmental biology; systematics, ecology, and evolution; physiology, anatomy, and nutrition; genetics, pathobiology.

### **Master of Science**

This is a general, nonthesis program which is applicable to interests which may not be met in a formal department. Curricula may be individually designed for persons working for agencies which require advanced, broad training in the biological sciences, or for those who wish to prepare for junior or community college teaching. Applicants should have a bachelor's degree in biology, zoology, botany, microbiology, or a strong background in biological and physical sciences including physics, college mathematics, and or-

ganic chemistry. Requirements for the degree include a four-credit research project and successful completion of a final written comprehensive examination on completed coursework.

Persons interested in the biology program should contact the chairperson, Graduate Advising Committee, for further information.

## **Botany and Plant Pathology (Bot)**

**Chairperson:** Subhash C. Minocha

**PROFESSORS:** Arthur C. Mathieson; Richard W. Schreiber

**ASSOCIATE PROFESSORS:** Alan L. Baker; Robert O. Blanchard; A. Linn Bogle; Garrett E. Crow; Leland S. Jahnke; William E. MacHardy; Subhash C. Minocha

**ASSISTANT PROFESSOR:** Thomas D. Lee

**ADJUNCT PROFESSOR:** Alex L. Shigo

**ADJUNCT ASSISTANT PROFESSOR:** Walter C. Shortle

**GRADUATE PROGRAM COORDINATOR:** Garrett E. Crow

Students admitted to graduate study in botany and plant pathology are expected to have adequate preparation in basic botany courses and in the physical sciences. All applicants must submit scores on the aptitude and advanced biology portions of the Graduate Record Examination.

The candidate for the Master of Science degree will meet the Graduate School's requirements for the degree and, in addition, will be required to defend a thesis based on field or laboratory research, after passing a comprehensive examination.

A student who is working toward the Doctor of Philosophy degree will be advanced to candidacy for the Ph.D. after a successful comprehensive examination and completion of the following language requirement: a reading knowledge of at least one foreign language. The guidance committee may request a reading knowledge of two foreign languages, or a reading knowledge of one foreign language and proficiency in a cognate field such as statistics or computer techniques. The student will be required to defend a dissertation that is to be a substantial contribution to botanical knowledge.

All botany and plant pathology graduate students without professional teaching experience will satisfy the following departmental teaching requirement: each student will assist a faculty member for one semester in teaching one botany course; a Ph.D. candidate will assist in teaching an introductory course and an additional semester in an advanced botany course. Each student will also register for a one-semester course in College Teaching, Inc 890 (optional for M.S. candidates, but required for the Ph.D.).

The department's areas for graduate study include: plant physiology, Mr. Jahnke, Mr. Minocha; plant ecology, Mr. Lee; systematic botany, Mr. Crow; phycology, marine-freshwater, Mr. Mathieson, Mr. Baker; plant pathology, Mr. Blanchard, Mr. MacHardy; plant morphology and anatomy, Mr. Bogle; mycology, Mr. Blanchard; cell biology, Mr. Schreiber; developmental botany, Mr. Minocha.

### **717. GENERAL LIMNOLOGY**

Special relationships of freshwater organisms to the chemical, physical, and biological aspects of their environment; factors regulating their distribution; and the primary and secondary productivity of lakes. Individual projects. Prereq: general ecology or equivalent. Mr. Baker, Mr. Haney. 4 cr.

### **719. FIELD LIMNOLOGY**

Principles of freshwater ecology, examined in a variety of habitats; the application of field instruments and computer methods used to study lakes and interpret data. Occasional Saturday field trips. Pre- or coreq: Bot 717; permission. Mr. Baker and Mr. Haney. Lab. 4 cr.

### **721. THE MICROSCOPIC ALGAE**

Survey of phytoplankton and periphyton in local marine and freshwater habitats. Identification, systematics, and evolution. Class and individual collection trips. Prereq: elem bot or survey of the plant kingdom. Mr. Baker. Lab. 4 cr.

### **722. MARINE PHYCOLOGY**

Identification, classification, ecology, and life histories of the major groups of marine algae, particularly the benthonic marine algae of New England. Periodic field trips. Prereq: elem bot or survey of the plant kingdom. Mr. Mathieson. Lab. 4 cr. (Alternate years; offered 1983-84.)

### **723. MARINE ALGAL ECOLOGY**

Distribution, abundance, and growth of marine plants in relation to their environment. Scheduled field trips and an independent research project are required. Prereq: Bot 722, Zool 715; /or permission. Mr. Mathieson. Lab. 4 cr. (Alternate years; offered 1982-83.)

### **724. FRESHWATER ALGAL ECOLOGY**

Survey of freshwater algal habitats; physiological explanation of population models. Individual experimental projects. Prereq: Bot 717 or 721; or permission. Mr. Baker. 4 cr.

### **727. ALGAL PHYSIOLOGY**

Survey of major topics in the physiology and biochemistry of marine and fresh water algae including: nutrition, metabolic pathways, reproductive physiology, storage and extracellular products, cell inclusion, growth and development. Prereq: plant physiology and introductory biochemistry or permission. Mr. Jahnke. 2 cr. (Alternate years; offered 1983-84.)

### **729. ALGAL PHYSIOLOGY LABORATORY**

Laboratory techniques useful in studying the physiology of freshwater and marine algae. Experiments in nutrition, metabolism, pigment and enzyme analysis. Small research project required. Prereq: concurrent registration in Bot 727 and permission. Mr. Jahnke. 2 cr. (Alternate years; offered 1983-84.)

### **730. MORPHOGENESIS**

Principles of differentiation; internal and external factors in cellular and organismic development. Prereq: plant physiology or permission. Mr. Minocha. 4 cr. (Alternate years; offered 1982-83.)

**732. CELL BIOLOGY**

Structure, behavior, and development of cells; the cellular basis of heredity. Prereq: one year of biological science and chemistry. Mr. Schreiber. 4 cr.

**742. PHYSIOLOGICAL ECOLOGY**

Physiological responses of plants to the physical environment; energy exchange, light, and photosynthesis, water relations, and mineral nutrition. Prereq: plant physiology or permission. Mr. Lee. Lab. 4 cr.

**747. AQUATIC HIGHER PLANTS**

Flowering plants and fern relatives found in and about bodies of water in the northeastern United States; extensive field and herbarium work, preparation techniques, and collections. Prereq: plant taxonomy. Mr. Crow. Lab. 4 cr. (Alternate years; offered 1982-83.)

**751. PLANT PATHOLOGY**

Nature, symptomatology, etiology, classification, and control of important plant diseases. Prereq: elem bot or equivalent. Mr. MacHardy. Lab. 4 cr.

**752. MYCOLOGY**

Parasitic and saprophytic fungi; growth, reproduction, and identification; preparation of pure cultures. Prereq: elem bot or equivalent. Staff. Lab. 4 cr.

**753. FOREST AND SHADE TREE PATHOLOGY**

Principles, symptomatology, etiology, and control of forest and shade tree diseases. Prereq: elem bot or equivalent. Mr. Blanchard. Lab. 4 cr.

**754. PRINCIPLES OF PLANT DISEASE CONTROL**

Epidemiology of plant diseases and relationship to cultural practices, resistant varieties, biological control, and chemical control; crop loss assessment, disease forecasting, and disease pest management. Lab. Prereq: Bot 751 or 753. Mr. MacHardy. 4 cr. (Alternate years; offered 1982-83.)

**761. PLANT GEOGRAPHY**

Distribution of plants, a consideration of vegetation types and floras, and problems of endemism with emphasis on North America; major influential factors such as geologic, climatic, edaphic, and biotic. Major contributions from Humboldt to the present time. Prereq: plant taxonomy or permission. Mr. Crow. 4 cr. (Alternate years.)

**762. MORPHOLOGY OF THE VASCULAR PLANTS**

Comparative form and structure of the major living and extinct groups; evolutionary modifications of the vegetative and reproductive organs, and the basic life history pattern. Prereq: survey of the plant kingdom. Mr. Bogle. Lab. 4 cr. (Alternate years; offered 1983-84.)

**764. MICROTECHNIQUE**

Methods of preserving cell and tissue structure, embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Prereq: permission. Mr. Bogle. Lab. 4 cr. (Alternate years; offered 1982-83.)

**795, 796. INVESTIGATIONS IN:**

A) Systematic Botany; B) Plant Physiology; C) Plant Pathology; D) Plant Anatomy; E) Plant Ecology; F) Mycology; G) Cell Biology; H) Phylogeny; I) Botanical Teaching; J) Morphology; K) Cell Physiology; L) Scientific Writing; M) Microtechnique. Individual projects under faculty guidance. Prereq: permission. 2-4 cr.

**803, 804. TOPICS IN DEVELOPMENTAL PLANT PHYSIOLOGY**

A) Fungal Physiology; B) Photosynthesis I; C) Photosynthesis II; D) Nitrogen Fixation; E) Morphogenesis; F) Reproductive Physiology of Plants; G) Photomorphogenesis; H) Plant Hormones; I) Water and Solute Translocation; J) Stress Physiology; K) Genetic Control of Plant Development; L) Regulation of Gene Expression; M) Metabolic Control Mechanisms in Plants. A series of seven-week, 2-credit, in-depth modules; two modules per semester (may vary, consult *Time and Room Schedule*). Consult PlSc or Bot departments for future semester offerings. Prereq: permission. PlSc and Bot staff. 2-26 cr.

**822. ADVANCED MARINE PHYCOLOGY**

Classification, ecology, and life histories of marine algae considered at an advanced level. Seminars, discussion, assigned reading, and laboratory. Mr. Mathieson. Prereq: Bot 722 or equivalent. 4 cr.

**851. CELL CULTURE**

Theory; principles fundamental to the culture of cells *in vitro*. Introduction to techniques of preparation and maintenance of animal, plant, insect, and fish cell cultures. Application of cell culture to contemporary research in biological sciences. Mr. Strout and staff, Mr. Metcalf, and Mr. Minocha. Prereq: permission. 4 cr. (Also offered as Micr 851 and AnSc 851.)

**852. METHODS IN MYCOLOGY**

Laboratory procedures employed in various aspects of mycological research from selection of research problem to journal publication. Prereq: Bot 752 or permission. Staff. 4 cr.

**853. ADVANCED PLANT PATHOLOGY**

Advanced theories and methods in plant pathology; plant pathogenesis; host/pathogen interactions. Prereq: Bot 751 or 753; permission. Mr. MacHardy. 4 cr. (Alternate years.)

**858. PLANT ANATOMY**

Anatomy of vascular plants; structure and development of basic cell and tissue types and of major organs of woody plants. Term project and final report. Prereq: intro bot or survey of the plant kingdom; permission. Mr. Bogle. 4 cr.

**867. ADVANCED SYSTEMATIC BOTANY**

Principles and rules of plant classification and nomenclature; plant families; field and herbarium work. Prereq: plant taxonomy. Mr. Crow. 4 cr. (Alternate years; offered 1982-83.)

**885-886. RECENT ADVANCES**

(A) Systematic Botany; (B) Plant Physiology; (C) Plant Pathology; (D) Plant Anatomy; (E) Plant Ecology; (F) Mycology; (G) Cell Biology; (H) Phycology; (I) Botanical Teaching; (J) Morphology; (K) Cell Physiology. Elective only with permission. 2 cr.

**895-896. INVESTIGATIONS IN BOTANY**

A) Systematic Botany; B) Plant Physiology; C) Plant Pathology; D) Plant Anatomy; E) Plant Ecology; F) Mycology; G) Cell Biology; H) Phycology; I) Botanical Teaching; J) Morphology; K) Cell Physiology; L) Scientific Writing; M) Microtechnique. Individual projects under faculty guidance. Elective only with permission. 2-6 cr.

**899. MASTER'S THESIS**

Six credits required. 6-10 cr.

**999. DOCTORAL RESEARCH**

## **Business Administration (Admn)**

**PROFESSORS:** Robert F. Barlow; Stephen L. Fink; Russell Haley; James O. Horrigan; Manley R. Irwin; John L. Korbel; Dwight R. Ladd; Barry Shore; Linda G. Sprague; William E. Wetzel, Jr.; Robin D. Willits; Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** Dale G. Broderick; John M. Burt, Jr.; Fred R. Kaen; Richard Martin-Diaz; Richard L. Mills; Melvin Sandler; Starr Schlobohm

**ASSISTANT PROFESSORS:** Richard W. Barber; Ahmad Etebari; Francine S. Hall; Michael Kole; Duncan LaBay; Richard Lamb; Michael J. Merenda; Rita Weathersby

The Whittemore School offers a program leading to the M.B.A. in formats designed for day students and practicing executives. The program is designed to prepare graduates for professional careers in administration in both profit and not-for-profit organizations in a rapidly changing world. The M.B.A. program is directed toward a broad preparation in general administration through the study of: 1) the increasing body of relevant knowledge drawn from the behavioral sciences, mathematics, and economics; 2) the existing and emerging processes and institutions of the functional fields of administration; and 3) the role of business and other organizations in a complex and turbulent society.

There is a consistent emphasis on developing basic analytical skills rather than on developing extensive technical expertise. Also, the program fosters the ability to utilize conceptual and theoretical material in the analysis and solution of practical problems.

Candidates for admission must possess a bachelor's degree from an accredited college or university. In addition, all candidates are expected to take the Graduate Management Admission Test (GMAT) given by the Educational Testing Service. Details concerning the dates and locations for these examinations may be obtained from Educational Testing Service, Box 955, Princeton, New Jersey 08540.

The Whittemore School welcomes applicants with an above-average academic record in any undergraduate specialty other than business or commerce. No previous exposure to business courses is expected. However, previous work in mathematics, economics, the behavioral sciences, and the branches of engineering is particularly useful for graduate study in administration. Because of the increasing use of mathematical concepts, models, and notation in the practice and study of administration, applicants should normally have successfully completed one year of college mathematics, preferably including an introduction to calculus. Students lacking this background may still enroll in the program provided they obtain adequate substitute preparation prior to beginning the program.

In all cases, the applicant's entire educational background, relevant experience, references, and professional aims will be considered in the admissions process. Exceptions may be made to any of the foregoing requirements by the committee on admissions.

### ***Day M.B.A. Program***

The Whittemore School curriculum for day students consists of an integrated sequence of 18 courses requiring two years of study, which can be started only in the fall semester. During the first year, 10 required courses in the basic disciplines (quantitative analysis, economics, and behavioral science) and the functional areas of management (accounting, marketing, operations management, and financial management) are integrated into an overall study of the process of administration. Special attention is also given to the study of the modern corporation as an economic, legal, and social organization by requiring all students to complete the course, *The Organization and Its Environment*.

The second year of the day curriculum continues the emphasis on overall management by requiring all students to complete *Business Conditions and Economic Forecasting* and *Business Policy*. In addition, with the help of a faculty adviser, the student will select the equivalent of six four-credit elective courses with some concentration in an area of special interest. Students are encouraged to select appropriate graduate-level courses offered by other colleges of the University as well as by the Whittemore School, and to undertake field studies or internships.

### ***Executive M.B.A. Program***

The curriculum for practicing managers contains the same course requirements as the day M.B.A. program, but is tailored to the context and scheduling needs of those working full-time at executive level jobs. The executive program begins each fall and, because of the cumulative nature of the program, participants are expected to stay on schedule with their class. The program is offered in Durham at the New England Center. The two-year program begins in September, with a full week of classes. Thereafter, classes are held twice each month in all-day Friday and Saturday sessions.

## **702. APPLIED STATISTICS**

Time series and cross-sectioned data; regression analysis; computerized statistical packages. Experimental design; surveys; contingency analysis. Prereq: basic statistics; permission. 4 cr.

## **705. OPERATIONS RESEARCH**

Synthesis and analysis of basic principles and methods of operations research applied to managerial decisions. Mathematical programming, networks, inventory, queuing, sequencing, scheduling, and Markovian models. Prereq: permission. 4 cr.

## **706. ADVANCED OPERATIONS RESEARCH**

Analysis and synthesis of complex operations research models. Project is undertaken by all students. Advanced mathematical programming (nonlinear, parametric linear, stochastic, and dynamic), stochastic inventory models, advanced queuing models, and heuristic programs. Prereq: Admn 705 or permission. 4 cr.

## **708. MODELING AND SIMULATION**

Modeling; formulation, data preparation, translation, validation, interpretation, and implementation. Discrete simulation models are developed and applied using a special purpose simulation language. Prereq: basic probability and statistics; permission. 4 cr.

## **712. ORGANIZATIONAL CHANGE**

Process of change in organizations. Change strategies; the change agent's role and relation to the client system. Bases of resistance to change and problems encountered by internal and external change agents. Theoretical reading material, cases, and exercises. Prereq: permission. 4 cr.

## **713. INTERPERSONAL AND GROUP DYNAMICS**

Dynamics of small groups through the use of the class itself as an intensive laboratory study group. Students examine their own behavior and its effects on others through the use of the Laboratory Training Group (T-group) and develop conceptual ability and behavioral skills. Readings in group dynamics, interpersonal relations, and sensitivity training. Prereq: permission. Lab fee. 4 cr.

## **714. CONFLICT MANAGEMENT**

Conflict among individuals, small groups, and organizations. Analysis of cases, readings, simulations, and roleplays (often using video tape) develops useful concepts and skills for dealing with conflict. Students examine their own behavior in coping with conflicts within the class. Field project required. Prereq: permission. 4 cr.

## **715. THEORY AND PRACTICE OF GROUP LEADERSHIP**

Comparison of and practice in leading task- and process-oriented groups. Student teams design presentations on leadership topics, then study their own leadership-membership issues. Each student also participates in and leads a process-oriented group. Prereq: Admn 713 or equivalent; permission. 4 cr.

## **718. COST AND MANAGEMENT**

Effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Analysis of cost behavior, direct and absorption

costing, cost-price-volume relationships, distribution costs, transfer pricing, and capital budgeting analysis. Prereq: permission. 4 cr.

## **720. AUDITING**

The attest function and the responsibility and professional ethics of the independent auditor in our society. Audit concepts, procedures, objectives, and reports. Operational audits, social audits, and management services. Prereq: Admn 717; /or permission. 4 cr.

## **722. ACCOUNTING SEMINAR**

Special topics. Prereq: Admn 717 or 718, depending on topics; permission. 4 cr.

## **723. TOPICS IN FINANCE**

Prereq: financial management. 4 cr.

## **724. ADVANCED TOPICS IN OPERATIONS MANAGEMENT**

Analysis and development of planning and control systems for the operations within an organization. Prereq: permission. 4 cr.

## **728. STATISTICAL DECISION MAKING**

Probability and statistics applied to decision problems. Bayesian approach to decisions under uncertainty, which explicitly injects prior judgements of decision makers and the consequences of alternative actions. Prereq: basic statistics; permission. 4 cr.

## **732. EXPLORATION IN ENTREPRENEURIAL MANAGEMENT**

Examination of the management of change and innovation with particular attention to the role of the entrepreneur in the management of new ventures. Characteristic behavioral, organizational, financial, and marketing problems of entrepreneurs and new enterprises. Prereq: permission. 4 cr.

## **741. TRANSPORTATION**

Problems of American transportation system. Economic structure of transportation industries; competition among the several modes. Public policy questions: merger, cost-benefit analysis of facilities, for example. Freight transportation; problems of passenger transportation, especially in urban areas. Prereq: permission. 4 cr.

## **742. MANAGEMENT INFORMATION SYSTEMS**

Concepts, design, and implementation of systems to provide information and support for managerial decision making. Use of computers, models, and behavioral factors from the manager's perspective. 4 cr.

## **745. INTERNATIONAL BUSINESS**

Issues and problems confronting managers in the international economy. Emphasis on problems of working across national borders rather than on those encountered within the framework of different national economies, cultures, and institutions. For managers working in a multinational enterprise. Prereq: permission. 4 cr.

## **747. FEDERAL TAXATION**

Current federal income, estate, and gift taxes and their effect on corporations, partnerships, and individuals. Tax analysis and decision making. 4 cr.

**751. ADVERTISING AND PROMOTION**

Advertising, personal selling, and other promotional tools to help solve marketing problems; advertising as a medium of communication and as a social-cultural force in the Western world. Prereq: marketing; permission. 4 cr.

**756. MANAGEMENT OF FINANCIAL INSTITUTIONS**

How financial institutions manage their sources and uses of funds; effect of external environmental factors upon the operation and performance of financial institutions. Optimal portfolio strategies for commercial banks, savings and loan associations, mutual savings banks, insurance companies, and pension funds. Implications of monetary theory for individual financial institution policies; credit analysis; competition among financial institutions; regulation of financial institutions. Prereq: financial management. 4 cr.

**761. SALES MANAGEMENT**

Principles and methods of successful salesmanship and management of the sales function. Selling experiences in fields of student interest; case studies, sales presentations; oral and written analyses of sales management issues. Prereq: marketing; permission. 4 cr.

**762. MARKETING WORKSHOP**

Integrative study of a real marketing situation in a business, nonprofit institution, or government agency. Student teams identify problem, research or collect data, suggest alternate solutions, and submit a recommended course of action. Prereq: one advanced marketing course; permission. 4 cr.

**770. PERSONNEL ADMINISTRATION**

Role of personnel administration and human resource management in achieving goals in "for-profit" and "not-for-profit" organizations. Functions of management; scope, technique, and current issues of personnel administration; organization of personnel activities and staff. How managers relate to personnel administration and interact with personnel administration staff and services. Prereq: permission. 4 cr.

**780. WOMEN IN MANAGEMENT**

Issues faced by women managers in complex organizations; problems associated with role expectations of women as they move into managerial positions traditionally filled by men. Prereq: senior or graduate standing. 4 cr.

**795. INTERNSHIP**

On-the-job skill development through fieldwork in an organization (business, industry, health, public service, etc.). Normally, supervision provided by qualified individual in the organization, with frequent consultation by a faculty sponsor. Written report required. Internships may be part- or full-time, with course credits assigned accordingly. 1-16 cr.

**800. INTEGRATIVE MANAGEMENT SEMINAR**

This course extends throughout the Executive MBA Program. Material and topics not offered in regular courses are offered here, as are distinguished speakers from business and government, field trips, issues of immediate concern, etc. 1 cr. To be repeated up to 4 cr. Cr/F.

**801. QUANTITATIVE METHODS**

Basic mathematical and statistical concepts applied to managerial decision making. Probability, statistics, decision trees, and mathematic models. 3 cr.

**803. HUMAN BEHAVIOR IN ORGANIZATIONS**

Understanding of behavioral science concepts and their use in the analysis of individual, group, and leadership relationships in organizations; skills in dealing with others at work. 3 cr.

**804. MANAGEMENT ORGANIZATION**

Theories of organization and analysis of contemporary forms and structure. Concern is with development of rational management processes in a dynamic society. 3 cr.

**806. FINANCIAL MANAGEMENT**

Concepts and techniques for determining the need for, the acquisition of, and the management of, financial resources of the business. 3 cr.

**808. MARKETING**

Identification, development, and retention of markets for the goods and services offered by the firm. Attention is given to the dynamics of demand and to the blending of the marketing mix. 3 cr.

**810. OPERATIONS MANAGEMENT**

Analysis of operational problems in the product and service sectors, focusing on production system design and development; emphasis on standards, capacity, inventory, scheduling, and control. 3 cr.

**811. THE ORGANIZATION AND ITS ENVIRONMENT**

Study of the modern corporation as a partly economic, legal, and social organization, including examination of widely held views of business and views of business people about themselves. 3 cr.

**815. FINANCIAL ACCOUNTING**

Introduction to the accounting methods employed in organizations to determine and communicate their financial position to interested parties outside the organization. 3 cr.

**816. MANAGERIAL ACCOUNTING**

Introduction to various models employed by organizations in the financial planning and control processes. 3 cr.

**817. BUSINESS CONDITIONS AND ECONOMIC FORECASTING**

Managerial effects of historical and forecasted movements in interest rates, national income, inflation, and unemployment. 4 cr.

**818. MANAGERIAL ECONOMICS**

An economics approach to the conceptualization, analysis, and management of revenues, costs, and profits. 3 cr.

**820. BUSINESS POLICY**

A "capstone" course, focused on industries, companies, and other organizations in operation, and studied through case examples, with emphasis on integration of materials covered in prior courses. 4 cr.

**830. INVESTMENTS ANALYSIS**

Capital market patterns and techniques useful for security analysis. Securities, market institutions, yield series, random walks, intrinsic-value analyses, portfolio management, analysis research projects. Prereq: Admn 806; permission. 4 cr.

**837. ADVANCED FINANCIAL ACCOUNTING**

Theory and practice as they contribute to the significance and limitations of the financial statement. Prereq: permission. 4 cr.

**848. LAW: USE AND APPLICATION IN BUSINESS**

Use and understanding of law as it applies to business judgement and policy decision making; basic legal rules and their application. Contracts, corporations, agencies, partnerships, administrative agencies, commissions, and other related business matters. Case-method teaching with outside research. 4 cr.

**850. MARKETING MANAGEMENT**

Practical application of theories taught in marketing. Planning, organization, and control of marketing activities in large corporations and small businesses; new product development; pricing policies; selection of channels of distribution; interrelationships between marketing, production, and finance. Sound policy formulation and decision making established through analysis of cases and computer simulation. Prereq: a basic marketing course. 4 cr.

**851. GOVERNMENT REGULATION OF BUSINESS**

Government policy as it affects managerial decision making. Conspiracy, monopoly, mergers, unfair practices, discrimination, and recent social legislation. 4 cr.

**852. MARKETING RESEARCH**

Identification, collection, and analysis of data for the marketing process. Strengths, limitation, environment, and evaluation of research in the marketing process. Prereq: marketing and statistics; permission. 4 cr.

**855. ADVANCED BUSINESS FINANCE**

Analytical tools and practical skills for recognizing and solving complex problems of business finance. Working-capital management; capital budgeting; cost of capital; capital structure; dividend policy. Prereq: Admn 806. 4 cr.

**861. THE PHILOSOPHY OF MANAGEMENT SCIENCE**

Study of management from a systems-analysis point of view. 4 cr.

**895. SPECIAL PROJECTS AND INDEPENDENT STUDY**

Projects, research, and reading programs in areas required for concentration. Sixty days advance approval of the student's plan of study by adviser and by proposed instructor required. Maximum of 8 credits, except by special permission. Maximum of 4 credits if Admn 896 has been taken for 8 credits. Variable cr. (May be repeated.)

**896. CONSULTING PRACTICUM**

Field consulting experience as a member of MBA Associates. Development of client relationships, diagnoses and analyses of actual problems, written and oral reports to clients, and administrative participation in MBA Associates. Prereq: permission. 4 cr. (May be repeated.)

**898. TOPICS IN ADMINISTRATION**

Special topics; may be repeated. Prereq: consent of adviser and instructor. 1-4 cr.

**Chemical Engineering (Ch E)**

**Chairperson:** Stephen S. T. Fan

**PROFESSORS:** Stephen S. T. Fan; Gail D. Ulrich

**ASSOCIATE PROFESSORS:** Ihab H. Farag; Virendra K. Mathur; Donald C. Sundberg

To be admitted to graduate study in chemical engineering, an applicant is expected to have completed a course of study substantially equivalent to that required for the degree of Bachelor of Science in Chemical Engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies.

A minimum of 30 credits, which must include Ch E 813, 815, 816, 823, and 832, is required for the Master of Science in Chemical Engineering degree. The core-courses requirement can be waived only in special cases with permission from the department faculty. A candidate for the Master of Science degree must prepare a thesis, for which a minimum of six credits will be allowed, unless the candidate is specifically exempted by the faculty because of previous research experience.

For students who are interested in graduate studies beyond the Master of Science degree, an inter-departmental Engineering Doctor of Philosophy program is available, which includes the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. For details refer to the section entitled Engineering Ph.D. Program.

Courses numbered between 600 and 699 may be taken for graduate credit by nonmajors only.

Permission of the instructor and consent of the student's adviser are required for enrollment in all chemical engineering courses.

**701. INTRODUCTION TO POLYMER ENGINEERING**

Principles of polymer chemistry, polymerization kinetics, polymer rheology, and material characteristics. Design and analysis of polymer reactors, extruders, molding machines, and other forming operations. Lab. 4 cr.

**705. NATURAL AND SYNTHETIC FOSSIL FUELS**

Study of U.S. and foreign reserves of coal, oil, and natural gas. Petroleum processing and refining. Coal, oil shale, and tar sand. Gasification and liquefaction of coal. Lab. 4 cr.

**712. INTRODUCTION TO NUCLEAR ENGINEERING**

Development of nuclear reactors; basic binding-energy physics; radioactivity; elements of nuclear reactor theory; engineering problems of heat transfer, fluid flow, materials selection, and shielding; environmental impacts. 4 cr.

**751. PROCESS SIMULATION AND OPTIMIZATION**

Techniques for computer-aided analysis of chemical processing systems. Development of mathematical models to describe process behavior. Application of optimization techniques. Prereq: a knowledge of FORTRAN programming. Lab. 4 cr.

**752. PROCESS DYNAMICS AND CONTROL**

Dynamic behavior of chemical engineering processes described by differential equations; feedback control concepts and techniques; stability and analysis. Lab. 4 cr.

**772. PHYSICOCHEMICAL PROCESSES FOR WATER AND AIR QUALITY CONTROL**

Origin and characterization of pollutants. Controls, including filtration, sedimentation, coagulation and flocculation, absorption and adsorption. Applied fluid mechanics, mass transfer, and kinetics. Thermal pollution, chemical treatment, oil spills on water, and aeration. Lab 4 cr.

**804. RADIATIVE HEAT TRANSFER**

Heat transmission in high-temperature operations and interaction of radiative and other transport mechanisms; radiation geometry; application of matrix algebra to radiative transfer in enclosures; zoning methods of temperature measurements. Analytical and empirical approximations of engineering use. Quantitative design of several furnaces and high-temperature systems. 3 cr.

**813. ADVANCED FLUID MECHANICS**

Basic equations describing behavior of static and dynamic fluid systems. The equations of motions and application to laminar and turbulent flow. Momentum and energy equations for advanced problems associated with flow inside conduits. Flow of compressible fluids and boundary layer phenomena. 3 cr.

**815. HEAT TRANSFER**

Steady-state and transient heat conduction in solids; heat convection; analytic solutions, similarity relations, boundary layer methods; radiation. 3 cr.

**816. DIFFUSIVE MASS TRANSFER**

Physical aspects of diffusion; theories of diffusion in dilute gases, dense gases, liquids, and solids; surface diffusion; mixing processes. Simultaneous heat and mass transfer. 3 cr.

**823. ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS**

The multicomponent open system; the volumetric and phase behavior of pure substances and of multicomponent systems at physical and chemical equilibrium, fugacity and activity; thermal properties of equilibrium, chemically reacting systems; introduction to statistical thermodynamics. 3 cr.

**832. ADVANCED CHEMICAL ENGINEERING KINETICS**

Specialized applied kinetics problems; catalysis; fast reaction and shock tubes; combustion and detonation processes; nonisothermal kinetics; heat and mass transfer in nonequilibrium, chemically reacting systems. 3 cr.

**852. ADVANCED PROCESS DYNAMICS**

Process dynamics for higher order processes and nonlinear processes. Modeling of complex process by differential equations, linearizing nonlinear elements, and adequately controlling the entire system. 3 cr. (Not offered every year.)

**890. LITERATURE REPORT**

Instruction in the use of the library for chemical engineering research, culminating in the preparation of a literature report on a topic of mutual interest to the student and the chemical engineering faculty. 1 cr.

**895, 896. GRADUATE INDEPENDENT STUDY**

Directed reading or investigation at the advanced level on topics in chemical engineering. 2-4 cr.

**897, 898. GRADUATE SEMINAR**

Discussion on topics of interest to graduate students and staff; reports of research progress; invited lectures by outside speakers. 0 cr.

**899. MASTER'S THESIS**

Original investigations in chemical engineering. Variable credit; 6 credits required.

**Chemistry (Chem)**

**Chairperson:** Frank L. Pilar

**PROFESSORS:** Alexander R. Amell; Kenneth K. Andersen; N. Dennis Chasteen; Clarence L. Grant; Colin D. Hubbard; Paul R. Jones; James D. Morrison; Charles W. Owens; Frank L. Pilar; Albert K. Sawyer; James H. Weber; Charles M. Wheeler, Jr.

**ASSOCIATE PROFESSOR:** W. Rudolf Seitz

**ASSISTANT PROFESSORS:** Christopher F. Bauer; Gary R. Weisman; Edward Hou Sen Wong

**GRADUATE PROGRAM COORDINATOR:** W. Rudolf Seitz

The Department of Chemistry offers programs leading to three graduate degrees: Doctor of Philosophy, Master of Science, and Master of Science for Teachers. Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting each new student's graduate work at the proper level. These examinations will be offered at the beginning of each semester on dates announced in the departmental graduate calendar.

The faculty of the chemistry department feels that the experience of teaching is a valuable part of the training of the graduate student. Therefore, all graduate students who are Doctor of Philosophy or Master of Science candidates will obtain some teaching experience during their tenure.

### ***Doctor of Philosophy Degree***

Admission to this program is based upon superior work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

Ph.D. candidates will be expected to demonstrate proficiency in reading chemical literature in one or two appropriate foreign languages; the analytical and physical divisions require German or Russian, the inorganic division requires German only, and the organic division requires German plus French or Russian. Candidates will also demonstrate to the doctoral committee that they have a broad basic knowledge of the field of chemistry: 1) by completing certain fundamental graduate courses; and 2) by means of a series of examinations in the major field. The principal emphasis of the last two years will be on the research project that will constitute the dissertation. During this time, doctoral candidates will present and defend an original research proposal before the doctoral committee.

### ***Master of Science Degree***

Admission to this program is based upon a superior undergraduate average and requires satisfactory work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

### ***Master of Science for Teachers Degree***

This program is offered for candidates who hold a secondary-school teacher certification in chemistry. This degree requires 30 semester hours in courses approved by the graduate coordinator. Persons interested in this degree should confer with the department's graduate program coordinator.

### ***Interdisciplinary Programs in Chemistry***

Graduate students in chemistry may elect to enter one of the interdisciplinary programs offered jointly with the chemistry department and other departments. In these programs, the graduate student, with the advice of the guidance committee, elects courses in chemistry and in the related disciplines, and writes the dissertation on a research problem appropriate to interdisciplinary treatment. Students interested in these programs should write to the chairperson of the department for further information.

### ***Analytical Chemistry***

#### **762. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS**

Theory, instrumentation, and application of methods such as atomic absorption, coulometry, emission spectrography, gas and liquid chromatography, polarography, potentiometry, IR and UV-VIS absorption spectrophotometry, and mass spectrometry to chemical analysis. Prereq: quantitative analysis; physical chemistry II as a pre- or corequisite; /or permission. Coreq: Chem 763. 3 cr.

#### **763. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LABORATORY**

Experimental parameters, error analysis, and applications of the methods covered in Chem 762. Coreq: Chem 762. 2 cr.

#### **830. ADVANCED OPTICAL METHODS**

Techniques of chemical identification and analysis utilizing optical instrumentation from the standpoint of theory and application. Topics include UV-visible absorption, luminescence, atomic spectroscopy, IR, NMR, x-ray methods and mass spectrometry. 3 cr. (Not offered every year.)

#### **831. ADVANCED ELECTRICAL METHODS**

Introductory electronics for chemists; theory and applications of important electrochemical techniques such as polarography and cyclic voltammetry. 3 cr. (Not offered every year.)

#### **833. CHEMICAL SEPARATIONS**

The use of various separation techniques prior to analysis; separations as methods of analysis. 3 cr. (Not offered every year.)

### ***Inorganic Chemistry***

#### **774. INORGANIC CHEMISTRY**

Basic theoretical concepts and their applications to inorganic reactions and compounds. Prereq: physical chemistry; /or permission. 3 cr.

#### **775. INORGANIC CHEMISTRY LABORATORY**

Synthesis and characterization of inorganic compounds with an emphasis on techniques not taught in other laboratory courses. 2 cr.

#### **803. ADVANCED INORGANIC CHEMISTRY I**

Survey of some concepts of modern inorganic chemistry, serving as general background material for all graduate students and as basic fundamentals for further courses in inorganic chemistry: periodicity, stereochemistry, and bonding in inorganic compounds, the crystalline state, reactions in solution, energetics, and elementary coordination chemistry. 4 cr.

#### **804. ADVANCED INORGANIC CHEMISTRY II**

Specialized topics for the advanced student. Topics may include advanced discussions of topics in Chem 803, inorganic reaction mechanisms, non-aqueous solvent systems, fluorine chemistry, bio-inorganic chemistry, solid state chemistry. 3 cr.

#### **847. ADVANCED INORGANIC CHEMISTRY III**

Modern theory applied to spectra, magnetism, kinetics, and thermodynamics of coordination compounds. The formation of and reactions of coordination compounds including catalytic reactions. Prereq: Chem 803 or permission. 3 cr. (Not offered every year.)

#### **848. ADVANCED INORGANIC CHEMISTRY IV**

The theory and practice of x-ray diffraction and the determination of crystal structure. Prereq: Chem 803 or permission. 3 cr. (Not offered every year.)

**Organic Chemistry****755. ADVANCED ORGANIC CHEMISTRY**

Methods of synthesis and determination of structure, including stereochemistry of complex organic compounds. 3 cr.

**756. ADVANCED ORGANIC CHEMISTRY LABORATORY**

Synthesis and structural determination of complex organic compounds, techniques for the separation, determination of purity, and identification of compounds by spectroscopic and chemical means. 2 cr.

**801. THEORETICAL ORGANIC CHEMISTRY I**

Discussion of theoretical and experimental methods used in study of reaction mechanisms and molecular stereochemistry. 4 cr.

**802. THEORETICAL ORGANIC CHEMISTRY II**

A continuation of Chem 801. 3 cr.

**811. SYNTHETIC ORGANIC CHEMISTRY I**

Advanced synthetic methods for preparing organic molecules. Prereq: permission. 3 cr.

**812. SYNTHETIC ORGANIC CHEMISTRY II**

A continuation of Chem 811. Prereq: permission. 3 cr.

**817, 818. SPECIAL TOPICS IN ORGANIC CHEMISTRY**

Specialized courses for the advanced student. Topics may include reaction mechanisms, stereochemistry, spectroscopy, molecular biochemistry, steroids, and organic sulfur compounds. 2 or 3 cr.

**Physical Chemistry****776. PHYSICAL CHEMISTRY III**

Quantum theory; spectroscopy; chemical bonding; statistical thermodynamics. Prereq: physical chemistry. Lab. 4 cr.

**778. CHEMISTRY OF LARGE MOLECULES**

Basic chemistry of high-molecular-weight compounds, including synthetic polymers and substances occurring in living systems. Elementary aspects of the structures, syntheses, and properties of large molecules, and their roles in modern science, technology, and living systems. Prereq: one semester of organic chemistry. 4 cr.

**805. ADVANCED PHYSICAL CHEMISTRY I**

An introduction to topics in quantum mechanics, group theory, and statistical thermodynamics which form the background of all areas of modern chemistry. 4 cr.

**806. ADVANCED PHYSICAL CHEMISTRY II**

Wave mechanics and quantum chemistry, spectroscopy, molecular structure; statistical thermodynamics, kinetics, and mechanism. Prereq: one year of physical chemistry. 3 cr.

**821. PHYSICAL CHEMISTRY—CHEMICAL KINETICS**

The kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to very rapid reactions. Prereq: one year of physical chemistry. 3 cr.

**822. PHYSICAL CHEMISTRY—CHEMICAL THERMODYNAMICS**

The foundations and interrelationships of the laws of thermodynamics. The methods by which the theoretical principles may be applied to practical problems. 3 cr.

**826. NUCLEAR AND RADIOCHEMISTRY**

Nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. 3 cr.

**827, 828. THEORETICAL CHEMISTRY I, II**

The modern concepts and mathematical formalism of quantum mechanics and applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. 3 cr.

**829. THEORETICAL CHEMISTRY III**

Statistical mechanics with applications to thermodynamics of nonideal systems, intermolecular forces, and chemical kinetics. Prereq: permission. 3 cr.

**General Offerings**

*Courses in which all areas of specialization participate.*

**708. RESEARCH TECHNIQUES**

Lectures and laboratory to show experimental methods and interpretation of results. Topics include chromatography, data handling, nuclear magnetic resonance, mass spectrometry, elementary electronics, infrared and ultraviolet spectroscopy, experimental design, and x-ray. 1-4 cr.

**807. INTRODUCTION TO RESEARCH**

A course to introduce the Doctor of Philosophy student to the planning, experimental methods, and interpretation of a research problem. Student presents and defends an original research proposal before a faculty committee. Must be completed satisfactorily by all doctoral students. Cannot be used for credit by Master of Science candidates. 2 cr.

**895, 896. COLLOQUIUM IN CHEMISTRY**

A) Inorganic Chemistry; B) Organic Chemistry; C) Theoretical Organic Chemistry; D) Physical Chemistry; E) Analytical Chemistry. 1-4 cr. Sections of the course may be taken to a total of 12 cr.

**897, 898. SEMINAR**

Presentation and discussion of recent investigations in chemistry. 1 cr. Cr/F.

**899. THESIS—PROBLEMS IN CHEMISTRY**

Conferences, library, and experimental work in some field of chemistry. Variable credit; 6 credits required.

**999. DOCTORAL RESEARCH**

## Civil Engineering (Ci E)

**Chairperson:** Paul J. Ossenbruggen

**PROFESSORS:** Paul L. Bishop; Otis J. Sproul; Tung-Ming Wang

**ASSOCIATE PROFESSORS:** Pedro A. DeAlba; Charles H. Goodspeed; David L. Gress; Louis H. Klotz; Paul J. Ossenbruggen

**ASSISTANT PROFESSORS:** Yen-hsi Chu; Robert M. Henry; Gary W. Jaworski; Windsor Sung

**ADJUNCT PROFESSOR:** Victor D. Azzi  
**GRADUATE PROGRAM COORDINATOR:** Charles H. Goodspeed

The Department of Civil Engineering offers the master's degree in civil engineering with the following areas of specialization: Structural, Materials, and Geotechnical Engineering; Environmental Engineering; and Ocean and Coastal Engineering.

A student admitted to graduate study in civil engineering must have completed a baccalaureate degree in engineering, mathematics, or science at an accredited college or university. If coursework or laboratory experience is deficient, the student will be required to fulfill, without graduate credit, all undergraduate prerequisites for graduate courses. In some cases the student's adviser may require additional undergraduate courses in order to achieve a well-integrated program of study.

Each entering graduate student is assigned an academic adviser who will assist the student in planning a program of study. The adviser will also assist the student in selecting a graduate advisory committee normally composed of at least two civil engineering faculty members and one non-civil engineering faculty member. The graduate advisory committee provides guidance to the student in course selection, thesis or project research, and will evaluate the student's overall progress.

A student in the master's program has the option of electing either a thesis (minimum of 24 course credits and 6 thesis credits) or nonthesis (minimum of 30 course credits and a zero-credit research project) option. There are no course requirements for either option; a minimum number of course credits is specified. Candidates electing the thesis option are required to submit a copy of their thesis, prepared in accordance with the Graduate School's *Thesis and Dissertation Manual*. A formal oral presentation/thesis defense is also required.

Candidates electing the nonthesis option are required to prepare a noncredit project paper and give a final oral presentation/project defense. In addition to the paper, the candidate must pass a departmental comprehensive examination on fundamental engineering concepts prepared and evaluated by the candidate's advisory committee. Project paper preparation guidelines are available in the departmental office.

A B average must be achieved for graduation. All students are required to register for Civil Engineering Seminar (CiE 800) for a minimum of two semesters.

A Doctor of Philosophy degree is administered through the College of Engineering and Physical Sciences Engineering Ph.D. Program. A candidate for the degree of Doctor of Philosophy must comply with the rules and regulations as outlined in the general requirements for graduate work in the Engineering Ph.D. Program.

### Areas of Interest

The faculty of the civil engineering department has research interests in the following areas. Students in the M.S. in civil engineering or the Engineering Ph.D. Program may select courses and research topics in these areas.

**Environmental Engineering:** Areas of interest include water and wastewater treatment; treatment of industrial wastes, such as those from tanneries, paper mills, metal finishers, and lithographers; treatment of hazardous wastes; dynamic control of the coagulation process in water treatment; kinetics of algal growth and nutrient uptake; pathogen survival during sludge composting; and groundwater pollution.

**Ocean and Coastal Engineering:** Areas of research include the design and analysis of offshore structures; soil-foundation interaction of offshore structures; estuarine circulation; sediment transport processes; and dynamic responses of coastal and ocean structures.

**Structural, Materials, and Geotechnical Engineering:** Topics of interest include fabric identification in sands by acoustic methods; instability of offshore slopes; influence of pore size and pore-size distribution on frost heaving of granular materials; influence of aggregate gradation on controlling the water-cement ratio of Portland cement, concrete while maintaining workability, and internally sealed concrete; coupled, twisting-bending vibrations of continuous curved beams; effects of rotary inertia and shear on multispan curved frames; vibrations of cable-stayed structures; computer-aided structural planning and design of buildings; computer graphics applications in structural engineering; finite element analysis; soil-structure interactions; and design investigations for the reconstruction of small/low-head, hydropower facilities.

### 701. ADVANCED SURVEYING

Instrumental and analytical photogrammetry. Conformal mapping and its application to the state plane coordinate systems. Geodetic surveying. Error theory and its application to the planning and adjustment of surveys. Application of electronic computers to surveying calculations. Prereq: surveying. Lab. 4 cr.

### 714. CONTRACTS, SPECIFICATIONS, AND PROFESSIONAL RELATIONS

Essential elements and legal requirements of engineering contracts; purposes and content of specifications; professional conduct, relations, registration, and ethics. Construction planning and management; cost analysis based on quantity surveys and unit-cost methods. Prereq: permission. 3 cr.

### 721. PAVEMENT DESIGN

Flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prereq: soil mechanics. 3 cr.

### 722. PROPERTIES AND PRODUCTION OF CONCRETE

Basic properties of hydraulic cements and mineral aggregates and their interactions in the properties of plastic and hardened concrete; modifications through admixtures; production handling and

placement problems; specifications; quality control and acceptance testing; lightweight, heavyweight, and other special concretes. Prereq: engineering materials or permission. 3 cr.

### **723. BITUMINOUS MATERIALS AND MIXTURES**

Considerations of major types of bituminous materials, asphalt cements, cutback asphalts, asphalt emulsions, and tars; influence of chemical composition on physical properties; desirable aggregate characteristics for bituminous mixtures; construction techniques; current practices for determining optimum asphalt contents. Prereq: engineering materials or permission. 3 cr.

### **731. NETWORK PLANNING AND SCHEDULING**

Application of critical path methods (CPM) and project evaluation review technique (PERT) to the design and control of engineering projects. Lab. 2 cr.

### **733. SYSTEMS ANALYSIS I**

Quantitative and economic techniques for optimum allocation of resources in planning and design of engineering systems. Topics include engineering economics, principles of optimization, matrix methods, and linear programming. Prereq: permission. 3 cr.

### **734. SYSTEMS ANALYSIS II**

A continuation of Systems Analysis I. More advanced topics of systems analysis, including nonlinear programming, numerical methods, and linear regression analysis. Application to the optimum design of structures, treatment plants, and other large-scale facilities. Prereq: Ci E 733. 3 cr.

### **740. RURAL WASTEWATER ENGINEERING**

Methods for collecting and treating wastewater in small communities and rural areas. Biological and physicochemical treatment systems for small communities; land application; soil absorption; gray water treatment; and septic treatment. Prereq: intro environ pollution control. 3 cr.

### **741. OPEN CHANNEL FLOW**

Energy and momentum principles in open channel flow; flow resistance; channel controls and transitions; unsteady open channel flows; convective and dispersive transportation of pollutants; and basic modeling techniques. Prereq: fluid mechanics. 3 cr.

### **743. ENVIRONMENTAL SAMPLING AND ANALYSIS**

Laboratory exercises in the techniques of water, wastewater, and solid-waste sampling and analysis. Interpretation of results from pollution surveys and operation of pollution control facilities; statistics of sampling and statistical evaluation of analytical data. Prereq: gen chem. Lab. 3 cr.

### **744. ENVIRONMENTAL LIMNOLOGY**

Biological, chemical, and physical processes that occur in lakes and impoundments are explored and interpreted with respect to the cultural activities of humans. Basic concepts of lake origin, morphometric and trophic status, water movement and stratification, nutrient cycling, etc. Current limnologically related problems are explored from the environmental engineering standpoint. Term proj-

ects involving laboratory field work and readings in the current scientific literature are required. Lab. 4 cr.

### **745. HYDROLOGY AND HYDRAULICS**

Occurrence and physical effects of water on the earth; meteorology, groundwater runoff and stream-flow routing, open-channel flow, reservoirs, control works, hydroelectric power, irrigation, drainage, and multipurpose projects. Prereq: fluid mechanics. 3 cr.

### **746. WASTEWATER TREATMENT PLANT DESIGN**

Choice of treatment units. Design of the components; preparation of a plan for a particular city that includes a suitable combination of the units previously designed. Prereq: water and wastewater engineering. 3 cr.

### **747. INTRODUCTION TO MARINE POLLUTION AND CONTROL**

Introduction to the sources, effects, and control of pollutants in the marine environment. Dynamic and kinetic modeling; ocean disposal of on-shore wastes, shipboard wastes, solid wastes, dredge spoils, and radioactive wastes; and oil spills. Prereq: water and wastewater engineering or permission. 3 cr.

### **748. SOLID WASTE MANAGEMENT**

Basic methods and theories of solid waste management systems, including collection and disposal methods. Incineration, sanitary landfill design, etc.; resource recovery techniques; hazardous waste management. Prereq: intro environ. pollution control or permission. 3 cr.

### **749. CHEMISTRY OF NATURAL WATERS**

Chemical equilibrium concepts applied to natural waters. Carbonate equilibria, acid-base equilibria, redox equilibria, complexation and surface phenomena. Equilibrium modeling of natural waters and treatment processes. Prereq: gen chem. 3 cr.

### **751. TRANSPORTATION PLANNING**

Transportation demand forecasting techniques applied to regional and urban situations. Calibration and use of mathematical models for forecasting land use, trip generation, trip distribution, modal choice, and trip assignment. Prereq: probability and/or statistics. 3 cr.

### **757. COASTAL ENGINEERING AND PROCESSES**

Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave and wave spectrum methods. Coastal processes and shoreline protection. Wave forces and wave-structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid mechanics or permission. 3 cr.

### **763. ADVANCED SOIL MECHANICS I**

Current methods of determining soil strength and compressibility. Application to earth pressure, bearing capacity, slope stability and settlement problems. Prereq: soil mech. 3 cr.

### **765. FOUNDATION ENGINEERING**

Subsurface investigation, excavation problems. Selection of foundation type. Design of footings, rafts, pile foundations, bulkhead walls. Prereq: Ci E 763; structural design concepts. 3 cr.

**766. GEOLOGICAL ENGINEERING**

The influence of geology in the design of foundations, underground excavations, tunnels, dams, and highways. Includes engineering properties of rocks, rock mechanics, and tunneling. Prereq: soil mechanics or permission. 3 cr.

**768. SEEPAGE ANALYSIS AND EARTH DAM DESIGN**

Groundwater flow, Darcy's law, flow nets, analytical techniques, Dupuit's theory, confined flow, flow through earth and rock structures, seepage toward wells, and earth dam design. Prereq: fluid mechanics and soil mechanics. 3 cr.

**782. TIMBER DESIGN**

Properties and characteristics of structural woods, mechanics of wood, connection methods, design of timber members, and connections in beams, columns, and trusses, and glued laminates of wood. Prereq: structural design concepts; permission. 2 cr.

**784. STRUCTURAL ANALYSIS BY MATRIX AND NUMERICAL METHODS**

Unifying concept of basic structural analysis theories; matrix and numerical methods of analysis, and their application by linear graph concepts using computers. Prereq: indeterminate structures. 4 cr.

**785. INTRODUCTION TO STRUCTURAL VIBRATIONS**

Dynamic analysis of single- and multi-degree-of-freedom systems. Simple beam and frame structures. Earthquake analysis and design. Co- or prereq: indeterminate structures. 3 cr.

**786. FINITE ELEMENT APPLICATIONS FOR SOLID MECHANICS**

Introductory course in the use of finite element methods for solution of various solid mechanics problems. Topics include basic matrix theory, direct stiffness method of structural analysis, development of finite element theory and modeling engineering problems with finite element modules. Prereq: intro. to computer programming, indeterminate structures, or permission. 3 cr.

**791. PRESTRESSED CONCRETE**

Design of prestressed and post-tensioned concrete sections in flexure and shear. Prestressing systems and ultimate strength methods will be introduced. Prereq: Ci E 793 or permission. 3 cr.

**793. STRUCTURAL DESIGN IN STEEL**

The design of members and connections: tension and compression members, beams, plate girders; riveted, bolted, and welded joints. Introduction to plastic design of beams and frames. Prereq: structural design concepts or permission. 4 cr.

**794. REINFORCED CONCRETE DESIGN**

The design of reinforced concrete members by Strength Design Theory including beams, columns, beam-columns, and slabs for strength and deformations. Prereq: structural design concepts or permission. 4 cr.

**795, 796. INDEPENDENT STUDY**

A limited number of qualified graduate students will be permitted to pursue independent studies under faculty guidance.

**800. CIVIL ENGINEERING SEMINAR**

Topics of interest to graduate students and staff; reports of research ideas, progress, and results; invited lectures by outside speakers. 1 cr. (Not to be applied toward graduation.)

**822. HIGHWAY AND AIRPORT ENGINEERING**

Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prereq: Ci E 721. 2-4 cr.

**855. MICROBIOLOGY OF WASTEWATER TREATMENT**

Detailed study of the microbiological aspects of wastewater treatment and the techniques used in the biological testing of water and wastewater. Prereq: water and wastewater engineering; general microbiology; /or permission. Lab. 4 cr.

**856. INDUSTRIAL WASTEWATER TREATMENT**

Detailed consideration of the origin, characteristics, and treatment of industrial wastewater; the theory and application of unit operations unique to the treatment and disposal of industrial wastes. Prereq: water and wastewater engineering. 4 cr.

**857. ADVANCED WASTEWATER TREATMENT**

Theory, application, and evaluation of new processes and developing techniques in water and wastewater reclamation and reuse. Prereq: Ci E 746. 4 cr.

**858. ADVANCED WASTEWATER SYSTEMS DESIGN**

A formal design to solve a practical problem in wastewater treatment; field data will be gathered, a laboratory-scale unit run, and a design submitted based upon the experimental findings. Prereq: Ci E 746; Ci E 856. Lab. 4 cr.

**859. ADVANCED WATER TREATMENT THEORY AND PRACTICE**

Current water treatment processes and pertinent articles will be critically assessed and discussed. The state of adsorption equilibria modeling and its application to coagulation, filtration, and column adsorption. Limitations of chemical equilibrium models in treatment. Prereq: Ci E 749; permission. 3 cr.

**864. THEORETICAL SOIL MECHANICS**

Theories and numerical methods for stress analysis, subgrade reaction, and laterally loaded piles. Constitutive laws in linear elasticity, perfect plasticity, and visco-elasticity. Finite element methods in continuum soil mechanics. Limit analysis and plasticity theory in soil mechanics. Prereq: Ci E 763, Ci E 786 or permission. 3 cr.

**865. SOIL STABILIZATION AND SITE IMPROVEMENT**

Techniques for improving support characteristics of soils for civil engineering structures. Compaction, admixtures, precompression, landfills. Prereq: Ci E 763, Ci E 765, or permission. 3 cr.

**866. SOIL TESTING FOR ENGINEERING PURPOSES**

Modern techniques for site investigation and measurement of soil properties in the field and laboratory; shear strength, permeability, consolidation, undisturbed sampling, classification, and in-situ stresses. Combination of lectures, laboratory and field trips. Prereq: Ci E 763 or equivalent. 2-4 cr.

**867. SOIL DYNAMICS**

Vibrations of elementary systems, wave propagation, elastic waves in layered systems, behavior of dynamically loaded soils, vibrations of foundations, isolation of footings, field measurements and instrumentation, design procedures for dynamically loaded foundations. Prereq: Ci E 765; Ci E 763. 2 cr.

**868. OFFSHORE GEOTECHNICAL PROBLEMS**

Techniques for sampling and testing of marine soils; design of offshore foundations. Stability problems under wave and earthquake loading. Prereq: Ci E 763; Ci E 765 or permission. 3 cr.

**881. ADVANCED STRUCTURAL ANALYSIS I**

Advanced structural theory and analysis, including multistory structures, beam columns, frames with variable moment of inertia, continuous trusses and bents, arches and curved frames, stiff rings, and closed frames. 4 cr.

**882. ADVANCED STRUCTURAL ANALYSIS II**

Methods of calculating stresses and deformations in plates and shells used in engineering structures. Bending of circular and rectangular plates. Membrane and flexural analysis of shells of revolution with application in the design of domes, pressure vessel tanks, and shell roofs. 4 cr.

**883. STRUCTURAL STABILITY**

Study of the elastic and inelastic buckling behavior of structures. Topics include: stability of columns, mathematical treatment of buckling problems and buckling criteria, lateral stability of beams, buckling of trusses and framed structures, and stability of rings and curved beams. 4 cr.

**884. DYNAMICS OF STRUCTURES**

Analysis of structures subjected to dynamic loadings. Free and forced vibrations with one- and multi-degrees of freedom. Vibrations of curved beams, multistory frames, and plate structures. Prereq: Ci E 785 or permission. 4 cr.

**885. APPLICATION OF SYSTEM THEORY TO STRUCTURAL ANALYSIS**

Comprehensive development of the stiffness matrix of structures. Intuitive concepts of topology and linear graphs and their application to structural frameworks. Analysis of structures using linear graphs. 4 cr.

**887. APPLICATION OF LINEAR GRAPHS TO CIVIL ENGINEERING**

Concepts of topology and linear graphs and their application to civil engineering planning of transportation, water and sewage distribution, and other networks. Network planning and management systems, including Project Evaluation Review Technique (PERT), Critical Path Methods (CPM), and PERT/cost procedures. 4 cr.

**890. TOPICS IN STRUCTURES**

Studies of topics of special interest and need of the student in structural design, analysis, and optimization. 2-4 cr.

**895, 896, 897. CIVIL ENGINEERING PROBLEMS**

The study and investigation of problems selected to meet the needs of the students. 2-4 cr.

**899. MASTER'S THESIS**

6-9 cr.

**Communication Disorders  
(Comm)**

**Chairperson:** F. Harry Tokay

**ASSOCIATE PROFESSORS:** Frederick C. Lewis; Frederick P. Murray; F. Harry Tokay  
**ASSISTANT PROFESSOR:** Charles W. Martin

**Program Objectives:** Students are prepared to function independently as clinicians within the field of communication disorders and to meet the academic and practicum requirements for the Certificate of Clinical Competence of the American Speech, Language, and Hearing Association in the area of speech pathology.

**Admission Procedures:** Before considering a graduate application, the Communication Disorders Program must have received: application, transcripts of previous academic work, three letters of recommendation, and the Graduate Record Examination aptitude test or Miller Analogies scores.

**Major Curriculum**

Applicants are expected to have a baccalaureate degree in communication disorders. The program is designed for part-time students; courses are offered in the evening and, on a concentrated basis, during the summer.

**Required Courses:** The following courses are required of all students: 706, Stuttering; 801, Articulation Disorders; 803, Organic Pathologies in Children; 804, Neuropathologies of Speech and Language; 806, Voice Disorders; 812, Diagnosis and Remediation of Language Disorders; 881, Research Methodology.

**Electives:** The following courses may be taken to supplement required courses to satisfy minimum credit hours and to accomplish academic requirements for certification by the American Speech, Language, and Hearing Association: 701, American Sign Language II; 702, American Sign Language III; 704, Basic Audiology; 705, Introduction to Auditory Perception and Aural Rehabilitation; 780, Seminar in Diagnosis of Speech and Language Disorders; 810, Clinical Practicum; 816, Advanced Clinical Audiology; 820, Graduate Seminar; 895, Special Topics in Communication Disorders; 899, Thesis.

**Clinical Practicum:** Up to six credits may be completed in practicum registration. The specific number of credits needed by a student will depend on undergraduate program and experience. Students are scheduled for three hours per week of direct client contact for each credit of practicum registration and will be helped to gain the practicum requirements for certification by the American Speech, Language, and Hearing Association.

**Written Examination:** All students must pass a written comprehensive examination designed to assess their mastery of the professional concepts of communication disorders in the areas of normative processes, pathologies, and remediation.

**Thesis Option:** Students may elect the option of writing a thesis. Such students must satisfactorily complete the course in Research Methodology and must present a proposal for acceptance. Upon completion of the research project, students must defend their theses in an oral examination and must gain approval of their theses committees. Six credits will be awarded for satisfactory completion of a thesis.

#### **701. AMERICAN SIGN LANGUAGE II**

Advanced phonology, syntax, and semantics of American Sign Language. Emphasis on grammatical processes that modulate meanings of signs in discourse and development of receptive language skills. Prereq: American Sign Language I; permission. 2 cr.

#### **702. AMERICAN SIGN LANGUAGE III**

Emphasis on the advanced linguistic principles of American Sign Language, including idioms, slang, and their place in the communication patterns of the deaf. Improvement of speed and accuracy in receptive and expressive skills for communicating with the deaf. Educational and vocational problems associated with deafness. Prereq: Comm 701; permission. 2 cr.

#### **704. BASIC AUDIOLOGY**

Normal hearing process and pathologies of the auditory system. Hearing screening, pure-tone testing, and speech audiometry. Prereq: anatomy and physiology of speech and hearing mechanisms or permission. 4 cr.

#### **705. INTRODUCTION TO AUDITORY PERCEPTION AND AURAL REHABILITATION**

Research, testing, and clinical procedures of auditory perception, applied to the communicatively impaired. Prereq: Comm 704; permission. 4 cr.

#### **706. STUTTERING**

Theoretical and therapeutic considerations of the stuttering syndrome; emphasis upon clinical management. Prereq: speech pathology II or permission. 4 cr.

#### **780. SEMINAR IN DIAGNOSIS OF**

#### **SPEECH AND LANGUAGE DISORDERS**

Principles and practice for diagnosis of speech and language disorders; examination procedures and measurement techniques. Prereq: speech pathology II. 4 cr.

#### **801. ARTICULATION DISORDERS**

Phonological theories as they relate to analysis and remediation of articulation disorders. 3 cr.

#### **803. ORGANIC PATHOLOGIES IN CHILDREN**

Speech/language disorders associated with neuro-motor and oro-facial pathologies in children; etiologies; methods of evaluation and treatment. 3 cr.

#### **804. NEUROPATHOLOGIES OF SPEECH AND LANGUAGE**

Principles concerning etiologies, instruments for evaluation, classification, and methods of clinical management including the team approach to rehabilitation of speech and language neuropathologies. 3 cr.

#### **806. VOICE DISORDERS**

Types, causes, and characteristics of functional and organic voice disorders. Specific evaluation of deviant vocal characteristics; treatment techniques for children and adults. 3 cr.

#### **810. CLINICAL PRACTICUM**

Practicum provides graduate student opportunity to apply advanced theoretical knowledge in clinical setting with speech, language, and hearing-impaired individuals. Diagnostic and therapy experience is supervised. Prereq: permission. (May be repeated up to 6 credits.) 1-6 cr.

#### **812. DIAGNOSIS AND REMEDIATION OF LANGUAGE DISORDERS**

Current diagnostic procedures and remediation techniques to evaluate and treat language disorders. 3 cr.

#### **814. PEDIATRIC AUDIOLOGY**

Auditory disorders in children, comprehensive diagnostic evaluations, current state of the art in hearing aids and amplification for children, and theoretical and clinical habilitation/rehabilitation of hearing-impaired children. 3 cr.

#### **816. ADVANCED CLINICAL AUDIOLOGY**

Advanced clinical testing for identification of organic and nonorganic hearing disorders; instrumentation and calibration procedures; ISO and ANSI standards. 3 cr.

#### **820. GRADUATE SEMINAR**

Current topics, recent investigations, and library research. (May be repeated up to 9 credits barring duplication of subject matter.) 3 cr.

#### **895. SPECIAL TOPICS IN COMMUNICATION DISORDERS**

Advanced study in specific areas; will involve an independent project. Prereq: permission. (May be repeated.) 1-3 cr.

#### **899. MASTER'S THESIS**

Prereq: permission. 6 cr.

## **Computer Science (CS)**

**Chairperson:** R. Daniel Bergeron

**PROFESSOR:** Shan S. Kuo

**ASSOCIATE PROFESSORS:** R. Daniel Bergeron; Eugene C. Freuder; Robert D. Russell

**ASSISTANT PROFESSORS:** Dov Harel; James L. Weiner

#### ***Master of Science in Computer Science***

**Admission Requirements:** High-level language programming, assembler language programming, data structures, and operating system fundamentals. Further experience in computer sci-

ence, mathematics, and/or electrical engineering will also be expected. All applicants must submit aptitude scores from the Graduate Record Examination. The advanced GRE in computer science is recommended.

**Degree Requirements:** Ten semester courses approved by the department, plus a one-credit graduate seminar in computer science, are required. All must be numbered over 700 and six of the ten must be chosen from the following group: CS 850-859, CS 898, CS 899 (may be used for two courses), E E 860, 865. A master's thesis/project is required.

**A maximum of four courses numbered 700 to 799 may be applied to the Master of Science degree in Computer Science.**

### 710. ADVANCED SYSTEMS PROGRAMMING

Topics in systems programming, including organization and implementation of assemblers, linkage editors, job schedulers, command language decoders. File systems, protection, security, performance evaluation, and measurement. Prereq: operating system fundamentals and assembler-language programming. 4 cr. (Not offered every year.)

### 711. PROGRAMMING LANGUAGES AND COMPILER CONSTRUCTION

Formal definition of programming languages; specification of syntax and semantics. Properties of algorithmic languages such as PL/I and ALGOL. Review of special purpose languages for list processing, symbol manipulation, data description and simulation; run-time representation of program and data structures; how these properties affect compilation. Prereq: intro to computer programming and data structures and processes, all modules. 4 cr.

### 712. COMPILER DESIGN

Formal languages and formal techniques for syntax analysis and parsing; organization of the compiler and its data structures; problems presented by error recovery and code generation. Classical top-down and bottom-up techniques currently in widespread use, general discussion of LL (k) and LR (k) parsers; automatic methods of compiler generation and compiler compilers. Students required to define a simple, nontrivial programming language and to design and implement its compiler. Prereq: C S 711. 4 cr. (Not offered every year.)

### 713. COMPUTER GRAPHICS

Input-output and representation of pictures from hardware and software points of view; interactive techniques and their applications; development of an interactive graphics system. Prereq: data structures and processes; operating system fundamentals; /or permission. 4 cr. (Not offered every year.)

### 714. INTRODUCTION TO PROGRAMMING SEMANTICS

Informal, nonmathematical introduction to descriptive techniques of denotational semantics. Provides framework needed to formally describe programming languages such as PASCAL. No previous knowledge of the theory of computation or of any particular programming language is assumed. Prereq: C S 711 or permission. 4 cr. (Not offered every year.)

### 715. INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Machine intelligence, representation and control issues, search methods, problem solving, learning computer vision, natural language understanding, knowledge engineering, game playing. Heuristic programming and the LISP language. Prereq: C S 711. 4 cr. (Not offered every year.)

### 716. DATA BASE TECHNIQUES

Data base analysis and design. Hierarchic, network, and relational models. Data normalization, data manipulation tools, data description languages, query functions and facilities, design and translation strategies, file and index organizations, data integrity and reliability, data security techniques, distributed database systems, actual usage of selected DBMS on computers. Prereq: data structures and processes. 4 cr. (Not offered every year.)

### 753. NUMERICAL METHODS AND COMPUTERS I

Use of scientific subroutine and plotter routine packages, floating point arithmetic, polynomial and cubic spline interpolation, implementation problems for linear and nonlinear equations, random numbers and Monte Carlo method, Romberg's method, optimization techniques. Selected algorithms programmed for computer solution. Prereq: calculus II; intro programming and FORTRAN. (Also offered as Math 753.) 4 cr.

### 754. NUMERICAL METHODS AND COMPUTERS II

Mathematical software. Computer solutions of differential equations, eigenvalues and eigenvectors. Prereq: intro programming and FORTRAN. (Also offered as Math 754.) 4 cr.

### 758. ANALYSIS OF ALGORITHMS

Introduction to use of basic mathematics in design and analysis of computer algorithms. Topics include O-notation, divide and conquer, the greedy method, dynamic programming, and NP-completeness. Prereq: mathematical proof; data structures and processes. 4 cr. (Not offered every year.)

### 790. TOPICS IN COMPUTER SCIENCE

Offered on an irregular basis with varying content. 1-4 cr.

**The following are the basic courses for the Master of Science degree in Computer Science.**

### 800. GRADUATE SEMINAR

Regularly scheduled seminars presented by outside speakers, UNH faculty and graduate students. Topics include reports of research ideas, progress and results. 1 cr. Cr/F.

### 850. OPTIMIZATION METHODS AND COMPUTERS

Optimization methods applied to problems in engineering, science, and management. Classical optimization methods; dynamic programming; integer programming; separable programming; search methods; geometric programming; combinatorial optimization. Prereq: Math 753 or permission. 3 cr.

**851. DATA BASE SYSTEMS**

Access control techniques; access strategies; data base software; data base related languages; data translation techniques; recovery and restart; restructuring; concurrent access methods; very large data bases; performance and evaluation; protection and security. Prereq: C S 710 or permission. 3 cr.

**852. SOFTWARE ENGINEERING**

Design approaches, implementation methodologies, and management techniques required to develop large, reliable software systems including applications-oriented systems. Team programming projects. Prereq: C S 710 or permission. 3 cr.

**853. ARTIFICIAL INTELLIGENCE**

Current approaches to machine intelligence and the simulation of human cognitive processes, including an introduction to recursive functions and programming with the LISP language. Heuristic programming, programs for game playing and natural language understanding, elementary theory of computability. Individual computer project required. Prereq: programming experience. (Also offered as E E 853.) 3 cr.

**854. AUTOMATA THEORY**

Formal language and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as E E 854.) 3 cr.

**855. OPERATING SYSTEMS TECHNIQUES**

Theoretical aspects of operating systems. Scheduling and resource allocation; deadlock; paging and segmentation; thrashing; synchronization; inter-process communication; cooperating sequential processes; protection and security; in-depth study of a complex system such as MULTICS. Prereq: C S 710 or equivalent. 3 cr.

**856. COMPUTER NETWORKS**

Distributed computer systems; techniques for connecting and controlling them. Tightly coupled systems to loosely coupled systems. Design, capabilities, and problems associated with different types of connections. Organizational possibilities for networks. Queuing theory applied to computer networks. Modelling and performance evaluation in distributed systems. Case studies of existing networks such as ARPANET. Prereq: E E 712 or equivalent; C S 710. 3 cr.

**857. COMPUTATIONAL LINGUISTICS**

Computational approach to the study of language. Problems in understanding and producing natural (or natural-like) language by computer and humans. Theories of parsing, meaning, knowledge representation, and communication, along with their mechanical embodiments will be studied and compared. Prereq: permission. 3 cr.

**890. ADVANCED TOPICS IN COMPUTER SCIENCE**

Offered on an irregular basis with varying content. 1-3 cr.

**898. READING COURSE**

1-6 cr.

**899. THESIS/PROJECT**

6 cr.

**Earth Sciences (ESci)**

**Chairperson:** Herbert Tischler

**PROFESSORS:** Franz E. Anderson; Wallace A. Bothner; Henri E. Gaudette; Cecil J. Schneer; Herbert Tischler

**ASSOCIATE PROFESSORS:** Francis S. Birch; Wendell S. Brown; Theodore C. Loder III; Paul A. Mayewski

**RESEARCH ASSOCIATE PROFESSOR:** James D. Irish

**ASSISTANT PROFESSORS:** Jo Laird; Wm. Berry Lyons

**ADJUNCT PROFESSOR:** Robert I. Davis

**GRADUATE PROGRAM COORDINATOR:** Francis S. Birch

The Department of Earth Sciences offers graduate work leading to the Doctor of Philosophy and Master of Science degrees in Earth Sciences with options in either geology or oceanography.

**Admission Requirements**

1) Students are expected to have completed at least one year of college chemistry, physics, and calculus;

2) Students with an undergraduate equivalent to a major in geology, chemistry, physics, mathematics, engineering, or in the biological sciences will be considered;

3) All applicants must submit scores on the aptitude portion of the Graduate Record Examination. Students lacking some background in a particular area may be admitted provided they are prepared to complete courses, without graduate credit, in which they may be deficient.

The option (geology or oceanography) a student wishes to follow will determine the level of necessary preparation. For instance, a student with an undergraduate major in physics who wishes to change direction to marine geology would have a number of deficiencies in geology to complete besides completing the core curriculum in oceanography. However, if that student wishes to pursue a program stressing physical oceanography, fewer deficiencies would probably have to be completed. The preparation of each student will be determined prior to the beginning of the first semester in residence in order to plan the course of study.

**General Degree Requirements for Master of Science and Doctor of Philosophy degrees in Earth Sciences, options in Geology and Oceanography**

Students in both the M.S. and Ph.D. programs are required to complete the core curriculum for their respective options.

Election of the core curriculum as well as additional courses will depend upon each individual student's specialization and/or preparation when entering the program.

**Geology Option:** This option is designed primarily for students with an undergraduate background in geology. Emphasis in this option may be placed upon: petrology-mineralogy; high temperature-isotope geochemistry; glaciology-glacial geology-geomorphology; geophysics; structural geology-tectonics; sedimentation-low temperature geochemistry; stratigraphy-paleontology.

The core curriculum for the option in geology normally includes: ESci 732, Geologic Mapping and Interpretation, 4 cr.; ESci 734, Applied Geophysics, 4 cr.; ESci 741, Geochemistry, 4 cr.; ESci 897, 898, Seminar in Earth Sciences, 1 cr. each semester of the first year.

Additional courses are to be selected from 700- or 800-level courses in the department and/or from courses numbered 600 or above in disciplines outside of the department (chemistry, hydrology, engineering, physics, mathematics, etc.).

**Oceanography Option:** This option is designed for students who wish to specialize in chemical, geological, or physical oceanography. Although the broad scope of oceanography will be presented, the emphasis in the program will be placed on estuarine, coastal, and continental shelf processes and environments.

The core curriculum for the option in oceanography normally includes: ESci 752, Chemical Oceanography, 3 or 4 cr.; ESci 758, Introduction to Physical Oceanography, 3 or 4 cr.; ESci 759, Geological Oceanography, 4 cr.; ESci 897, 898, Seminar in Earth Sciences, 1 cr. taken each semester of the first year.

Additional courses are to be selected from 700- or 800-level courses in the department and/or from courses numbered 600 or above in disciplines outside of the department (chemistry, hydrology, engineering, physics, mathematics, etc.).

#### **Specific Requirements for the Master of Science degree**

In addition to any deficiencies, students must satisfactorily complete a minimum of 30 credits, which may include the 14 credits accumulated in the core curriculum. Eight credits (not including 899) must be taken at the 800 level. Students must complete a master's thesis and give an oral presentation of the results. All students are required to participate in the instructional activities of the department.

#### **Specific Requirements for the Doctor of Philosophy degree**

1) reading knowledge of an appropriate foreign language; 2) passing a qualifying examination, generally after two years of study; 3) teaching experience equivalent to at least half-time for one year; 4) completion of significant original research described in a dissertation; and 5) passing an oral defense of that work.

Course requirements are flexible and are determined by the student's individual guidance committee.

#### **725. IGNEOUS AND METAMORPHIC PETROLOGY**

The origin, formation, and geologic history of igneous and metamorphic rocks as determined from field and laboratory studies of occurrences, mineral assemblages, rock composition, and texture. Inter-

pretation of rock and mineral compositional diagrams; application of experimental investigations. Prereq: mineralogy and petrography. Field trips. Lab. 4 cr.

#### **732. GEOLOGIC MAPPING AND INTERPRETATION**

Standard methods of geologic field mapping; interpretation of geologic maps and aerial photographs of selected areas. Course includes field mapping excursions to local areas and several extended exercises in selected areas of the northern Appalachian Mountains. Lab fee includes transportation and housing in the field. Prereq: structural geology or permission. Lab. 4 cr.

#### **734. APPLIED GEOPHYSICS**

Gravity, magnetic, seismic, electrical, and thermal methods of investigating subsurface geology. Fieldwork and use of computers in data analysis. Prereq: one year of calculus; intro geol; one year of college physics; /or permission. Lab. 4 cr.

#### **741. GEOCHEMISTRY**

Thermodynamics applied to geologic processes; geochemical differentiation of the earth; the principles and processes that control the distribution and migration of elements in geological environments; stable and radiogenic isotopes in geologic processes. 4 cr.

#### **752. CHEMICAL OCEANOGRAPHY**

Water structure, chemical composition and equilibrium models; gas exchange; biological effects on chemistry; trace metals and analytical methods. Laboratory includes short cruise abroad R/V *Jere A. Chase*. Prereq: permission. Lab (optional). 3 or 4 cr.

#### **754. MODERN SEDIMENTS**

Modern sediments from a process-oriented viewpoint. Emphasis on shallow-water modern marine sediments, including shelf, beach, and estuarine deposits. Animal/sediment interactions will be considered. The laboratory investigates applied techniques in modern sediment analysis. Prereq: intro to geology or oceanography or permission. 4 cr.

#### **758. INTRODUCTION TO PHYSICAL OCEANOGRAPHY**

Ocean basins; physical properties of seawater; atmosphere-ocean interaction; general ocean circulation; waves and tides; continental shelf and near-shore processes; instrumentation and methods used in ocean research. Simplified physical and mathematical models demonstrate the important concepts. Prereq: one year of calculus and college physics; intro oceanog; /or permission. Variable credit: 3 cr. without lab; 4 cr. with optional lab and field project.

#### **759. GEOLOGICAL OCEANOGRAPHY**

Major geological features and processes of the ocean floor; geological and geophysical methods; plate tectonics. Prereq: permission. 4 cr.

#### **762. GLACIAL GEOLOGY**

The glacial environment: glacier dynamics and glacial erosion and deposition. Review of world glacial stratigraphy in light of causes of glaciation and climatic change. Field trips. Prereq: intro geol; geomorphology; /or permission. Lab. 4 cr.

**771. MINERAL DEPOSITS**

Introduction to the processes of formation, geological characteristics, and environments of deposition of metallic mineral deposits, and a brief survey of the unique nature and importance of the mineral industries. Prereq: structural geology, petrography. 4 cr.

**781. PHYSICAL GEOLOGY**

Materials and structures of the earth and erosive agents that modify them. Laboratory and field trips. For certified elementary or high school science teachers or for students in master's degree programs in education who need an introduction to the earth sciences. (Not available for credit after completing a basic geology course.) 4 cr.

**782. HISTORICAL GEOLOGY**

Evolution of physical features and life on the earth. Fossil organisms; methods of historical geology; laboratory and field trips. Prereq: ESci 781 or equivalent. For certified elementary or high school science teachers or for students in master's degree programs in education who need an introduction to the earth sciences. (Not available for credit after completing a basic geology course.) 4 cr.

**795. TOPICS IN EARTH SCIENCES**

A) Areal Geology; B) Geochemistry; C) Geomorphology, Advanced; D) Geophysics; E) Glacial Geology, Advanced; F) Groundwater Geology; G) Historical Geology, Advanced; H) Industrial Minerals; I) Micropaleontology; J) Mineral Fuels; K) Mineralogy, Advanced; L) Optical Crystallography; M) Ore Deposits; N) Paleontology, Advanced; O) Petrology, Advanced; P) Regional Geology; Q) Sedimentation; R) Stratigraphy; S) Structural Geology, Advanced; T) Marine Geology; U) Physical Oceanography; V) History of Geology; W) Earth Science Teaching Methods; X) Senior Synthesis; Y) Chemical Oceanography; Z) Glaciology, Advanced. Special problems by means of conferences, assigned readings, and field or laboratory work, fitted to individual needs from one of the areas listed above. 1-4 cr.

**813. X-RAY CRYSTALLOGRAPHY**

Theory and practice of diffraction of X rays by crystals; lattices, symmetry, and structure analysis. Prereq: mineralogy or physical chemistry or equivalent. 3 cr. (Not offered every year.)

**820. ADVANCED IGNEOUS PETROLOGY**

Extensive readings and discussions of original sources and recent literature with reference to classical petrologic provinces. Application of thermodynamics and phase-rule chemistry to igneous petrogenesis. Prereq: permission. 3 cr. (Not offered every year.)

**821. ADVANCED METAMORPHIC PETROLOGY**

Extensive readings and discussions of original sources and recent literature dealing with the facies concept, equilibrium reactions, reaction kinetics, and other chemical aspects of metamorphic petrogenesis. Prereq: permission. 3 cr. (Not offered every year.)

**841. ANALYTICAL GEOCHEMISTRY**

Introduction to the theory, instrumentation, and applications of analytical methods in geochemistry. Prereq: permission. 3 cr. (Not offered every year.)

**842. SEDIMENTARY GEOCHEMISTRY**

Chemistry of recent and ancient estuarine, marine, and lacustrine sediments, emphasizing both kinetic and thermodynamic principles in the understanding of biogeochemical processes, authigenic mineral formation, and pore water chemistry in these environments. 3 cr. (Offered alternate years.)

**843. THERMODYNAMICS IN GEOLOGY**

An application of classical thermodynamics to geologic systems, emphasizing the relationships of heat, work, energy, entropy, and free energy. Prereq: one year of calculus, chemistry and physics; adequate background in geology. 3 cr. (Offered alternate years.)

**845. ISOTOPE GEOLOGY**

Discussion of element abundance and isotope formation; radioactive decay as applied to geologic systems, detailed investigation of K-Ar, Rb-Sr, U-Pb and Sm-Nd systems, and geologic-oceanographic applications of stable isotopes. Laboratory involves mass spectrometric and chemical techniques of isotopic analysis. Course includes the completion of a laboratory project. 4 cr.

**852. ADVANCED CHEMICAL OCEANOGRAPHY**

Readings on physical, chemical, and biological processes that affect the distribution of chemical components in estuaries and the open ocean. Laboratory includes projects investigating selected processes. Prereq: ESci 752; /or permission. 4 cr.

**856. ESTUARINE AND MARINE SEDIMENTATION**

Unique aspects of sedimentation in marine and estuarine water with special emphasis on cohesive, fine-grained estuarine sediment erosion, transportation, and deposition. Laboratory includes basic statistical analysis of sedimentological data. Course includes completion of a project. Prereq: permission. 3 cr. (Not offered every year.)

**858. DYNAMICAL OCEANOGRAPHY**

The hydrodynamics of such ocean phenomena as waves, tides, and ocean turbulence; wind-driven circulation on the continental shelf and deep ocean will be treated in detail. Prereq: ESci 758; M E 707; /or permission. 4 cr. (Not offered every year.)

**859. DATA ANALYSIS METHODS IN OCEAN AND EARTH SCIENCES**

Methods of analysis of oceanographic, geophysical, geological, and environmental data. An introductory tutorial on important mathematical concepts precedes the development of the bases for a number of data analysis techniques; digital filtering, regression analysis, cross-spectral analysis, objective analysis, and elementary inverse theory, etc. Students use these techniques on real data. Prereq: differential equations or equivalent. 3 cr.

**862. GLACIOLOGY**

Physical principles controlling glacier activity and the implications of glacier activity in the context of current scientific problems. Prereq: geomorphology, glacial geology, one year of college calculus, one semester each of college physics and chemistry/or permission. Lab and/or field project optional. 3-4 cr. (Offered alternate years.)

**895, 896. TOPICS IN EARTH SCIENCES**

Advanced work on an individual or group basis under members of the graduate staff. Sections of this course are the same as those listed under ESci 795. Prereq: permission of department chairperson and staff concerned. 1-4 cr. (May be taken more than once.)

**897, 898. SEMINAR IN EARTH SCIENCES**

A review and discussion of recent literature in the earth sciences. Required of graduate students in earth sciences. 1-3 cr.

**899. MASTER'S THESIS**

6 cr.

**999. DOCTORAL RESEARCH****Economics (Econ)**

**Director of Economic Studies:** Marc W. Herold

**PROFESSORS:** Robert F. Barlow; Manley R. Irwin; John J. Korbel; Sam Rosen; Kenneth J. Rothwell; Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** Allan J. Braff; Richard W. England; Marc W. Herold; Richard W. Hurd; Richard L. Mills; Robert C. Puth; Allen R. Thompson

**ASSISTANT PROFESSORS:** Michael A. Conte; Marilyn B. Power; Evangelos O. Simos

**Whittemore School of Business and Economics**

The economics faculty of the Whittemore School, together with the resource economics faculty of the Institute of Natural and Environmental Resources, offers a program leading to the degree of Doctor of Philosophy. In addition, the economics faculty offers a plan of study culminating in the degree of Master of Arts.

Admission to both programs is open to students whose undergraduate work shows evidence of superior ability and motivation and who manifest promise of serious scholarship. Normally, the appropriate undergraduate preparation will include exposure to economic reasoning and methodology, including mathematics and statistics. Those who warrant special consideration, even though their backgrounds are deficient, should be aware that remedial work may be required.

Admission requirements in addition to those established by the Graduate School include the Graduate Record Examinations (aptitude and advanced test in economics).

**Doctor of Philosophy Degree**

Ph.D. candidacy requires written evidence of proficiency in economic theory, the history of economic thought and methodology, and quantitative methods, as well as successful completion of two advanced courses and two research workshops (4 credits each) and demonstrated knowledge of one foreign language. At present, workshops exist in finance, political economy, labor economics, econometrics, international development, and resource economics.

Information about fields available for the dissertation as well as other details of the doctoral program can be obtained from the director of economic studies.

**Master of Arts Degree**

The candidate for a master's degree may take a general course of study or the thesis option. The general requirements of the Graduate School and the following major requirements must be met:

1) 32 semester hours of graduate study, which may include 8 hours of thesis work;

2) Minimum of 24 semester hours in courses numbered 700 and above and at least 12 hours in courses numbered 800 and above apart from Econ 899, Master's Thesis;

3) Maximum of 8 semester hours in approved courses numbered 600 and above taken in related disciplines;

4) Written evidence of proficiency in economic theory;

5) Successful completion of an 800-level course in areas of history of economic thought and quantitative economics.

**711. ECONOMIC FLUCTUATIONS**

Recurrent movements of prosperity and depression; emphasis on causes and public-policy implications. Prereq: intermed macro or permission. 4 cr.

**715. MARXIAN ECONOMIC ANALYSIS**

Marx's analysis of capitalism within the classical and radical tradition; methodology; organization of capital; labor theory of value; accumulation of capital; growth and distribution; economic crises. Critical evaluation of Marx's analysis. Prereq: intermed micro; intermed macro; /or permission. 4 cr.

**720. U.S. ECONOMIC HISTORY**

From colonial times to the present. Applied economic theory; economic models and interpretation of data. Influence of technology, industrialization, foreign trade, monetary factors, and government; noneconomic factors. Prereq: intermed micro and macro; /and permission. 4 cr.

**721. EUROPEAN ECONOMIC HISTORY**

Western European and Mediterranean economies from medieval times to the Common Market. Economic models and interpretation of data. Capital accumulation, technology, trade, industrialization, monetary factors, and the role of government; relevant noneconomic factors. Prereq: intermed micro or macro; /or permission. 4 cr.

**727. ADVANCED ECONOMETRICS**

Provides familiarity with standard proofs and propositions of theoretical econometrics and develops competence in the application of relatively advanced econometric techniques. Use of computer required. Prereq: permission. 4 cr.

**735. ECONOMICS OF FINANCIAL MARKETS**

Economic analysis of financial market systems. Topics include financial market functions, theories of saving and investment, financial intermediation, flow-of-funds analysis, loanable funds theory, interest rate forecasting, portfolio theory, capital-asset pricing models, structure of interest rates

(including term-structure theory), and macroeconomic models of the financial sector. Prereq: money and banking or permission. 4 cr.

### **736. SEMINAR IN MONETARY THEORY AND POLICY**

Contemporary developments in monetary theory and the evaluation of policy measures. Prereq: money and banking or permission. 4 cr.

### **741. SEMINAR IN PUBLIC FINANCE—THEORY AND POLICY**

Selected topics in contemporary theoretical and policy problems of public finance. Prereq: public finance or permission. 4 cr.

### **745. INTERNATIONAL TRADE**

Contemporary issues in international economic theory and policy. Analysis of trade theory, dynamics of world trade and exchange, and international commercial policy. Prereq: international econ or permission. 4 cr.

### **746. INTERNATIONAL FINANCE**

International monetary mechanism; balance of payments, international investment; exchange rates, adjustment systems, international liquidity, foreign aid, multinational corporations. Prereq: prin of econ. 4 cr.

### **747. MULTINATIONAL ENTERPRISES**

The internationalization of economies. Growth and implications of the multinational corporation at the level of systems. Theories of imperialism, international unity/rivalry; theories of direct investment; the exercise of influence and conflict, technology transfer, bargaining with host country; effects on U.S. economy. Prereq: permission. 4 cr.

### **751. GOVERNMENT REGULATION OF BUSINESS**

Analysis of government policy with reference to such problems as conspiracy, monopoly, mergers, unfair practices, and discrimination; legal and economic appraisal of government policy alternatives. Prereq: govt reg of busi or permission. 4 cr.

### **752. TECHNOLOGY, INFORMATION AND PUBLIC POLICY**

The U.S. as a post-industrial economy. Impact of microelectronics on manufacturing, distribution, employment, and competition; domestic and international policy implications of information transfer. 4 cr.

### **755. COLLECTIVE BARGAINING**

Historical development of the U.S. labor movement and the industrial relations system. Contemporary collective bargaining issues; the role of public policy in industrial relations. 4 cr.

### **756. LABOR ECONOMICS**

Recent developments in labor market analysis and public policies related to contemporary labor issues. Labor supply, the structure and stratification of labor markets, economic discrimination, unemployment and poverty, inflation, and wage-price controls. Prereq: labor econ or permission. 4 cr.

### **757. ECONOMICS OF WORK**

Organization of work under capitalism. Competing management philosophies, response of workers to management practices. Satisfaction of workers with their jobs, trends in worker productivity, alternative work arrangements, and worker participation in management. Prereq: labor unions and the working class; labor econ; /or permission. 4 cr.

### **758. LABOR MARKET MODELING**

Labor supply and demand forecasting models. Demographic projections of supply. Industrial, occupational projections of demand. Simulation models for analyzing the impact of manpower and welfare programs. Use of the computer involved in doing assigned exercises, but no prior familiarity with computers is required. Prereq: permission. 4 cr.

### **768. SEMINAR IN ECONOMIC DEVELOPMENT**

An advanced reading seminar. Topics include: Methodologies underlying economic development theory; industrialization and post-import substitution, state capitalist development, stabilization policies, appropriate technologies, the capital goods sector, agricultural modernization schemes, and attempts at transition to socialism. Prereq: permission. 4 cr.

### **769. CASE STUDIES IN ECONOMIC DEVELOPMENT**

A) Southeast Asia; B) Cost-Benefit and Project Analysis; C) Africa; D) Latin America; E) Middle East. Problems and policies in selected countries; evaluations of national plans, programs, and projects; comparative analysis. Prereq: prin of econ or permission. 4 cr.

### **798. ECONOMIC PROBLEMS**

Special topics; may be repeated. Prereq: permission of adviser and instructor. 2 or 4 cr.

### **825. MATHEMATICAL ECONOMICS**

Principal mathematical techniques and their application in economics. Topics covered: matrix algebra, derivatives, unconstrained and constrained optimization, linear and nonlinear programming, game theory, elements of integral calculus. 4 cr.

### **826. EMPIRICAL ECONOMIC METHODS**

Application of statistical and econometric methods to problems in economics. Topics covered: ordinary least squares, generalized least squares, distributed lag models, omitted variables, simultaneous equation models, two-state least squares. 4 cr.

### **857-858. HISTORY OF ECONOMIC THOUGHT**

Development of economic thought, with emphasis on different methodological approaches and the development of theories of value and income distribution. Focus on major economic thinkers of the 18th through 20th centuries, including Smith, Ricardo, Marx, neo-classical economists, Keynes, Dobb, and Sraffa. 4 cr.

### **873. MACROECONOMIC THEORY**

Advanced analysis of such aggregates as national income, total output, employment, and the general price-level. Examination of the major aggregate models. 4 cr.

**874. ECONOMIC DYNAMICS**

Dynamic analysis of macro- and microeconomic models. Dynamic stability, disequilibrium dynamics, growth theory, and stochastic processes. Prereq: Econ 825, 873, and 877; /or equivalent. 4 cr.

**877. MICROECONOMIC THEORY**

Topics in microeconomics with emphasis on recent developments in such areas as general equilibrium analysis, welfare economics, demand and production theory, and capital theory. 4 cr.

**878. ECONOMICS OF CENTRALIZED AND MIXED SYSTEMS**

Origins of Soviet planning; planning agriculture and industry; Soviet growth models; input-output and material balances; optimal planning; value and prices in socialist economies; economic reforms; theories about nature of socialist societies. Mechanisms of centralized planning in their socio-historical context. Prereq: Econ 873, Econ 877, or permission. 4 cr.

**895. INDEPENDENT STUDY**

Variable cr.

**896. RESEARCH WORKSHOP**

A) Finance; B) Political Economy; C) Labor Economics; D) Econometrics; E) Resource Economics; F) International Development. 2 cr. Cr/F.

**899. MASTER'S THESIS**

8 cr.

**999. DOCTORAL RESEARCH****Education (Educ)**

**Chairperson:** Roland B. Kimball

**PROFESSORS:** Angelo V. Boy; Donald H. Graves; Roland B. Kimball; Carleton P. Menge

**ASSOCIATE PROFESSORS:** Michael D.

Andrew; Richard F. Antonak; Charles H. Ashley; Jason E. Boynton; John J. Carney; John G. Chaltas; Ellen P. Corcoran; Ann L. Diller; David D. Draves; Edward J. Durnall; David J. Hebert; Sharon N. Oja; M. Daniel Smith; Deborah E. Stone; Dwight Webb

**ASSISTANT PROFESSORS:** Grant L. Cioffi; Susan D. Franzosa; Maryanne Galvin; Jane A. Hansen; Bruce L. Mallory; Karen A. Mazza; Richard L. Schwab; Mary Bowes Winslow

**ADJUNCT PROFESSOR:** Donald D. Durrell

**ADJUNCT ASSOCIATE PROFESSOR:**

Richard H. Goodman

**GRADUATE PROGRAM COORDINATOR:**  
David D. Draves

**Admission to Graduate Standing**

Admission to graduate standing in the Department of Education is granted to applicants meeting the entrance requirements of the Graduate School and accepted by the department. Applications must include Graduate Record Examination scores for the aptitude test.

**Admission Requirements**

1) Above average academic credentials; 2) above average scores on the Graduate Record Examination; 3) three strongly supportive letters of recommendation attesting to intellectual and personal competence from persons in a position to judge the applicant's preparation and fitness for graduate work; 4) applicants for the Certificate of Advanced Graduate Study must meet the preceding admission requirements and also possess a master's degree in an appropriate specialty, and follow general admission procedures.

The education department's admissions committee acts upon applications to all departmental programs three times per year following Graduate School application deadlines (NOTE: Applications for full-time study in the Counseling M.Ed. and M.A. programs are acted upon only during the April admissions meeting.).

**Concluding Degree Experience**

Candidates in a Master of Education program usually conclude degree work by completing one of five types of concluding experiences: 1) research thesis; 2) written comprehensive examination; 3) development of a written set of professional theses followed by an oral examination; 4) clinical experience; 5) teaching internship-related project. Students must enroll in Education 899, Master's Thesis, when the research thesis is selected.

Candidates in the Master of Arts in Teaching program usually conclude degree work by completing a project closely related to the teaching internship.

Candidates in the Certificate of Advanced Graduate Study program in counseling usually conclude degree work by completing one of three types of concluding experiences: 1) research thesis; 2) written comprehensive examination; 3) development of a written set of professional theses followed by an oral examination.

**Master's Degree Programs in Education**

Seven graduate programs lead to the Master of Education degree: counseling, developmental disabilities, early childhood education, educational administration and supervision, elementary education, reading, and secondary education.

Most programs are available to part-time admitted graduate students. Since not all courses are offered each semester, students should consult the current *Time and Room Schedule* for course offerings.

**Counseling**

**Program Information:** Angelo Boy, Maryanne Galvin, David Hebert, and Dwight Webb.

The Counseling Program offers students a choice of either the Master of Arts degree or the Master of Education degree. Enrollment in the M.A. program is very limited because of the thesis requirement. The M.A. degree requires completion of seven core courses (28 credits), elective courses (8 credits), and the completion of a research thesis (6 credits), for a total of 42 credits. These 42 credits should be viewed as a minimum number because in many cases it is determined that the student needs additional coursework in statistics and research methodology in order to complete the thesis

requirement. The Master of Education degree requires completion of the seven core courses (28 credits), elective courses (8 credits), and successful completion of a written comprehensive essay examination.

These programs prepare professional counselors to function in a variety of institutions, organizations, and agencies dedicated to the educational, vocational, social, and psychological development of the person, within the context of school and university settings, human service programs, human development centers, and rehabilitation agencies. Graduates of the program are engaged in providing preventive and restorative services to persons who possess normal and developmental concerns. Graduates are typically involved in the team delivery of services and work in collaboration with other human services professionals.

**Core Requirements** (28 credits): Educ 820, Counseling Theory and Practice; 821, Psychology of Career and Personal Development; 822, Assessment in Counseling; 823, Group Counseling; 824, Psychological Adaptation; 825 and 826, Counseling Internship.

**Electives** (8 credits): Educ 818 and 819 may serve as electives. In addition, in consultation with the adviser, electives may be selected from graduate-level courses which are related to the behavioral sciences and offered by a department or school in the University.

#### ***Developmental Disabilities***

**Program Information:** Richard F. Antonak, Bruce L. Mallory, M. Daniel Smith, (Education); Ann D. Ury, (Occupational Therapy); F. Harry Tokay, (Communication Disorders)

This program prepares graduates to assume responsibility in the service delivery system for developmentally disabled citizens (i.e., mental retardation, cerebral palsy, convulsive disorders, autism, multiple handicaps), including: 1) directing the interaction of various therapies and disciplines providing service to the developmentally disabled, 2) coordinating, supervising, and administering human service programs for developmentally disabled, 3) planning and evaluating human service programs, and 4) maintaining and improving such programs through public relations, community awareness, and grant procurement activities.

Candidates are expected to have prior experience in one of several related professions (such as nursing, medicine, occupational therapy, communications disorders, psychology, physical therapy, social work, education) and/or a strong theoretical background in these disciplines. At present, this program is available only to part-time admitted graduate students.

**Required Courses** (28 credits): Educ 883, Advanced Psychology of Human Learning; 854, Survey of Developmental Disabilities; 855, Service Delivery Systems in Developmental Disabilities; Occupational Therapy 701, Managing Resources for the Developmentally Disabled; Educ 856-857, Field Practicum and Seminar in Developmental Disabilities; and one course in the area of administration.

**Electives** (8 credits, minimum): elective courses may be selected, in consultation with the adviser, from the offerings of graduate departments of the University to meet individual needs and professional objectives. A maximum of eight elective credits may be earned by completing a master's research thesis (Educ 899).

**Concluding Experience:** Each degree candidate must pass a written comprehensive examination.

#### ***Early Childhood***

**Program Information:** Donald Graves, Bruce L. Mallory, Deborah Stone.

The Early Childhood Program primarily serves experienced child workers who wish to improve their professional competence and broaden their career options. The program prepares participants as early childhood resource specialists, competent to assume roles as master teacher, program supervisor, curriculum consultant, staff development director, parent-home educator, family agency coordinator, or community college instructor. The program emphasizes field-based experience coordinated with extensive coursework in related academic disciplines. Students enroll on either a part-time or full-time basis. During the academic year, students are responsible for staffing early learning centers in local school districts, private nursery and kindergarten programs, day care centers, development centers, and special services facilities. Candidates engage in coursework and seminars concurrent with an internship experience through study on campus two afternoons and evenings per week. They also provide workshops for staff and parent groups and carry out independent studies in areas of special interest and significance.

**Core Curriculum** (28 credits): Educ 841, Child Development for the Early Childhood Professional; 843, Environment for Early Childhood; 800-801, Internship and Seminar in Teaching; 846, Assessment in Early Childhood; 848, Contemporary Influences in Early Childhood; 850, Foundations of Early Childhood Education; 895, Independent Study in Education.

**Electives** (8 credits): Other graduate-level courses within or outside of the Department of Education are acceptable depending upon the student's background, individual goals, and adviser's approval.

**Special Needs Option:** Students who wish to specialize in the education and development of handicapped or exceptional children between birth and eight years may apply to the Special Needs Option. Students choosing this option will concentrate on the assessment of children with developmental disabilities or delays, the design of appropriate environments and individual programs, working with parents, and understanding the administrative and legal issues relating to young handicapped children.

**Core Curriculum** (34 credits): Education 841, 843, 846, 848, 800-801, (see above); and Education 760, Introduction to Young Children with Handicaps; 847, Diagnosis and Educational Planning for Young Handicapped Children; 849, Supporting Parents of Young Handicapped Children.

**Electives** (8 credits): Other graduate-level courses within the Early Childhood, Developmental Disabilities, and other Department of Education programs, as well as graduate-level courses from outside the department, are acceptable with permission of the student's adviser.

**Concluding Experience:** Degree candidates must successfully complete one of the following: comprehensive examination, research thesis, or major integrating project.

#### ***Educational Administration and Supervision***

**Program Information:** Charles Ashley, Jason Boynton, Roland Kimball, and Mary Winslow.

The program is designed for the experienced

teacher to become qualified in the broad area of supervision and administration, grades K-12. Emphasis is on the elementary and secondary school principalship and general instructional supervision.

**Core Requirements** (28 credits): Educ 872, Educational Program Evaluation; 865, Educational Supervision; 853, Seminar in Curriculum Study; 861, Public School Administration; 863, Seminar in Educational Administration; 867, Legal Aspects of School Administration; and 869, Practicum in Educational Administration.

**Electives** (8 credits) are individually planned, with major portion selected from the following: Educ 797, Seminar in Contemporary Educational Problems; 864, Personnel and Communication in Educational Organizations; 868, Collective Bargaining in Public Education; 886, Philosophy of Education; 895, Independent Study in Education; Admn 713, Interpersonal and Group Dynamics; Admn 803, Human Behavior in Organizations; Soc 740, Culture Change; Soc 770, Culture, Personality, and Society; and Soc 888, Sociology of Education: the Cultures of Poverty and Affluence.

**Concluding Experience:** 1) Comprehensive oral examination based on the thesis prepared by the candidate or 2) major research study related to school administration, curricula, or educational supervision.

#### **Elementary and Secondary Education**

**Program Information:** Teacher Education Committee: Michael Andrew, chairperson; Ellen Corcoran; John Chaltas; Susan Franzosa; Karen Mazza; Sharon Oja; and Richard Schwab.

The elementary and secondary education programs are designed for teachers who have been granted teaching certificates and who intend to become or to continue to be classroom teachers.

**Core Curriculum** (12 credits): Selections may be made from: Educ 785, Tests and Measurements; 853, Seminar in Curriculum Study; 883, Advanced Psychology of Human Learning; 884, Advanced Human Development; 886, Philosophy of Education; and Soc 838, Sociology of Education: Social Organization of Schools and Community.

**Electives** (18 credits): In consultation with and with the approval of the student's adviser, electives may be taken in specialized areas from within the Department of Education, in the student's major field, or in some combination of the two. A student using the research thesis option of the concluding experience will normally use 12 elective credits for Educ 881, Methods and Techniques of Educational Research (4 cr.) and Educ 899, Master's Thesis (8 cr.).

**Concluding Experience:** Degree candidates must successfully complete one of the following: theses plus oral examination, or research thesis.

#### **Reading**

**Program Information:** John Carney, Jane Hansen, Grant Cioffi.

The reading program provides professional training as a teacher of reading, clinician, and consultant for individuals seeking certification as reading specialists. The program is designed to meet standards recommended by the International Reading Association for the professional training of reading personnel and certification requirements of the state of New Hampshire for reading specialists. The program trains students in the areas of elementary and secondary reading foundations, clinical competencies, consultant and supervisory skills, and research capabilities.

**Core Curriculum** (28 credits): Educ 807, Foundations of Reading Instruction; 808-809, Clinical Diagnosis and Remediation of Reading Difficulties and Disabilities; 810, Comprehensive Reading Methods in the Secondary School; 813, Field Practicum; 814, Seminar in Reading. Choose one of the following: 734, Children's Literature; 776, Reading for Children with Special Needs; 806, Approaches to Language Art Instruction; 815, Reading and the Adult Learner.

**Electives** (8 credits): The remainder of courses are selected in consultation with the adviser. They may be from the offerings of the Department of Education or reflect an interdisciplinary approach with other graduate departments at the University. A student using the research thesis option as a concluding experience will use the 8 credits for Educ 899, Master's Thesis.

**Concluding Experience:** Degree candidates will successfully complete one of the following: written examination, theses plus oral examination, or research thesis.

#### **Degree Programs for Preservice Teachers: Master of Arts in Teaching and Master of Education**

**Program Information:** Michael Andrew or Ellen Corcoran.

The Department of Education offers two graduate programs for prospective elementary and secondary teachers, leading to either the Master of Arts in Teaching (M.A.T.) degree or the Master of Education (M.Ed.) degree. Both programs require a minimum of 30 credits and are designed for two types of students: 1) those in the Five Year, Undergraduate-Graduate Program who entered the teacher preparation program as undergraduates at UNH and have thus satisfied some of the requirements for teacher certification prior to graduate study; 2) those who have completed an undergraduate program, either at UNH or elsewhere, with little or no coursework in education. Specialization may be developed for teaching at the primary, middle, and/or high school levels. Students entering these master's degree programs normally have completed a bachelor's degree program with a major outside the field of education.

*All professional education requirements for certification must be met either prior to or as a part of the master's degree programs for preservice teachers.* These professional requirements include: Educ 500, Exploring Teaching; 700, Educational Structure and Change; 701, Human Learning and Development; Educational Psychology; 703, Alternative Teaching Models; 705, Alternative Perspectives on the Nature of Education; and 800-801, Internship and Seminar in Teaching. Additional requirements for all prospective elementary teacher candidates include 706, Introduction to Reading Instruction in the Elementary School, and two from the following: Math 621, Number Systems for Elementary School Teachers; Math 622, Geometry for Elementary School Teachers; Math 623, Topics for Elementary School Teachers; or Math 703, Mathematics Education K-6.

All candidates who do not participate in the Live, Learn, and Teach program must complete, or have completed prior to admission, either: 1) Educ 500, Exploring Teaching, or 2) a one-semester teacher aide experience, or its equivalent, with a supportive recommendation from school staff.

The Live, Learn, and Teach program is a 10-

credit, seven-week experiential summer program which may be an integral part of the master's degree program, particularly for those students who have done no previous coursework in education. The summer program consists of Educ 831 or 835 (4 cr.), 703 (4 cr.), and 700 (2 cr.). The program also satisfies the requirement for Educ 500.

#### ***Master of Arts in Teaching (Elementary and Secondary)***

The M.A.T. program is most appropriate for students who wish to do a portion of their degree coursework outside of the Department of Education, in their major teaching field or associated fields.

**Professional Education Requirements (12-40 credits):** Either as part of the degree program or prior to admission, these required certification courses or their equivalents must be successfully completed: Educ 500, 700, 701, 703, 705, 800, 801. (In addition, for elementary teacher certification: Educ 706 and two courses from Math 621, 622, 623, 703.)

**Courses Related to the Teaching Field (12 credits):** These courses are to be selected in consultation with one's adviser, from departments other than the Department of Education. (For those seeking elementary teacher certification, a required mathematics course may be included.)

**Electives (0-6 credits):** These courses, selected in consultation with one's adviser, may be from those offered by the Department of Education or other departments.

**Concluding Experience:** Degree candidates must successfully complete one of the following: project, theses plus oral examination, or research thesis.

#### ***Master of Education (Elementary and Secondary)***

The Master of Education degree for preservice teachers is designed for those students who wish to concentrate their graduate study in the Department of Education.

**Professional Education Requirements (12-40 credits):** Either as part of the degree program or prior to admission, these required certification courses or their equivalents must be successfully completed: Educ 500, 700, 701, 703, 705, 800, 801. (In addition, for elementary teacher certification: Educ 706 and two courses from Math 621, 622, 623, 703.)

**Courses for an Education Area Concentration (12 credits):** In consultation with one's adviser, courses offered by the Department of Education will be selected which concentrate on some aspect of the field of education. (For those seeking elementary teacher certification, Educ 706 may be included.)

**Electives (0-6 credits):** These courses, selected in consultation with one's adviser, may be from those offered by the Department of Education or other departments.

**Concluding Experience:** Degree candidates must successfully complete one of the following: project, theses plus oral examination, or research thesis.

#### ***Certificate of Advanced Graduate Study***

A Certificate of Advanced Graduate Study (C.A.G.S.) is available in two programs: Counseling, and Educational Administration and Supervision.

#### ***Counseling (C.A.G.S.)***

This program is designed for those who possess a master's degree in counseling or an equivalent master's degree and want to pursue further study toward the Certificate of Advanced Graduate Study. The candidate for this certificate must successfully complete 32 graduate credits beyond the master's degree, and one of the following before graduation: written examination, oral examination, or research thesis.

**Required Education Courses (20 credits):** Educ 827, Administration of Counseling Services; 828, Advanced Counseling Theory and Practice; 829, Advanced Counseling Internship; 830, Research in Counseling; and 884, Advanced Human Development.

**Electives (12 credits):** Elective courses available within the Counselor Education Program are: Educ 818, Principles and Procedures in Rehabilitation and Educ 819, Social and Psychological Aspects of Disability.

In consultation with one's adviser, electives may be selected from graduate-level courses offered by the departments of education, business administration, economics, English, history, home economics, mathematics, political science, psychology, and sociology.

**Concluding Experience:** Degree candidates must successfully complete one of the following: research thesis; written examination; or written set of professional theses followed by an oral examination.

#### ***Educational Administration and Supervision (C.A.G.S.)***

Designed for individuals who possess a master's degree or graduate study equivalent to that outlined in the University of New Hampshire M.Ed. program in Educational Administration and Supervision and who wish advanced preparation for careers as school superintendents, assistant superintendents, business managers, state department of education personnel, vocational education coordinators, curriculum coordinators, or educational personnel in private organizations.

Candidates must complete a significant field project and internship of 12 semester hours within the administrative environment in which they intend to function. Courses are required in five competency areas: institutional analysis, organizational behavior, policy analysis, managerial leadership, and instructional leadership. Twelve semester hours include electives outside the Department of Education.

The program is based upon the following:

1) Students in this program pursue basic courses in educational administration and supervision as well as electives which will enable them to function more adequately within a specific administrative environment.

2) Because of the complex role of the school administrator, persons seeking preparation as administrators must demonstrate intellectual and personal competence of superior quality.

3) The graduate program for administrators will emphasize the ability to apply the relevant facts and formulations derived from administrative theory and research in the solution of significant operational problems.

Contact: Charles H. Ashley, associate professor of education, Morrill Hall, for further details.

## **700. EDUCATIONAL STRUCTURE AND CHANGE**

A) Educational Structure and Change; B) Education in America: Backgrounds, Structure, and Function; C) Governance of American Schools; D) School and Cultural Change; E) Teacher and Cultural Change; F) Social Perspectives of Conflict in the Schools; G) Nature and Processes of Change in Education; H) What Is an Elementary School?; I) Schooling for the Early Adolescent; J) Children with Special Needs: History and Models; K) Curriculum Structure and Change; L) Stress in Educational Organizations. Organization, structure, and function of American schools; historical, political, and social perspectives; nature and processes of change in education. Two- and 4-credit courses offered each semester (listed in department prior to preregistration; refer to *Time and Room Schedule*). Minimum of 4 credits required for teacher certification. Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

## **701. HUMAN DEVELOPMENT AND LEARNING: EDUCATIONAL PSYCHOLOGY**

A) Human Development and Learning: Educational Psychology; B) Human Development: Educational Psychology; C) Human Learning: Educational Psychology; D) Developmental Bases of Learning and Emotional Problems; E) Learning Theory, Modification of Behavior, and Classroom Management; F) Cognitive and Moral Development; G) Evaluating Classroom Learning; H) Deliberate Psychological Education; I) Sex Role, Learning, and School Achievement; J) The Development of Thinking. Child development through adolescence, learning theory, cognitive psychology, research in teaching and teacher effectiveness, and evaluation, all applied to problems of classroom and individual teaching and therapy. Full 4-credit course and 2-credit minicourses offered each semester (listed in department prior to preregistration; refer to *Time and Room Schedule*). Minicourses emphasize either development (first half of semester) or learning (second half). Candidates for teacher certification are required to have at least 2 credits of development and 2 credits of learning, or the full 4-credit course (701A). Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

## **703. ALTERNATIVE TEACHING MODELS**

A) Alternative Teaching Models; B) Developing Teaching Plans; C) Alternative Strategies for Maintaining Classroom Control; D) Nature and Goals of Social Studies: K-12; E) Social Studies Instructional Materials: K-12; F) Teaching Elementary and Middle School Science; G) Language Arts for Elementary Teachers; H) Experiential Curriculum; I) Children with Special Needs: Teaching Strategies. Basic teaching models, techniques of implementation, and relationships to curricula. Two- and 4-credit courses offered each semester (listed in department prior to preregistration; refer

to *Time and Room Schedule*). Minimum of 4 credits required for teacher certification. For secondary teacher candidates, the appropriate methods course, taught in the department of the major, usually satisfies this requirement. Educ 703B is required for candidates for elementary teacher certification who do not complete 703C, D, F, or G. Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

## **705. ALTERNATIVE PERSPECTIVES ON THE NATURE OF EDUCATION**

A) Contemporary Educational Perspectives; B) Controversial Issues in Education; C) Ethical Issues in Education; D) Concepts of Teaching: Differing Views; E) Curriculum Theory and Development; F) Readings on Educational Perspectives; G) Philosophy of Education; H) The Scope of Education; I) Education as a Form of Social Control; J) School Reform Theories; K) Schooling and the Rights of Children; L) Education, Inequality, and the Meritocracy; M) Readings in Philosophies of Outdoor Education; N) Alternative Perspectives on the Nature of Education; O) Classrooms: The Social Context; P) Teaching: The Social Context; Q) School and Society. Students formulate, develop, and evaluate their own educational principles, standards, and priorities. Alternative philosophies of education; contemporary educational issues. Two- and 4-credit courses offered each semester (listed in department prior to preregistration; refer to *Time and Room Schedule*). Minimum of 4 cr. required for teacher certification. Prereq. for teacher certification students: Exploring Teaching and permission, which is accomplished by signing the appropriate course roster in the Teacher Education Office. Prereq. for students not seeking teacher certification: permission, as described above. 2 or 4 cr.

## **706. INTRODUCTION TO READING INSTRUCTION IN THE ELEMENTARY SCHOOLS**

Reading process; current procedures and materials; diagnostic techniques; practicum experience. Course satisfies reading requirement for prospective elementary teachers in the five-year teacher education program and may be included in the 12 required graduate credits in education at the graduate level. Course may also be taken for undergraduate credit before entrance into fifth year; in this case the course satisfies reading requirement but is not applicable toward the 12 required graduate credits. Prereq: exploring teaching. 4 cr.

## **707. APPROACHES TO TEACHING READING AT THE SECONDARY LEVEL**

*The Reading Curriculum in The Secondary School:* structural components (developmental, corrective, remedial); materials and methods of instruction and appraisal; instruments of measurement and evaluation in the comprehensive secondary reading program. 2 cr. *Teaching Reading through the Content Areas: Alternatives and Application:* new approaches, concepts, and methodologies of teaching reading through content materials; workshop to develop and produce instructional strategies and materials for an integrated reading-content program. 2 cr.

(Two credits of 707 may be used to satisfy 2 credits of Educ 700).

**733. INTRODUCTION TO THE TEACHING OF WRITING**

Development of writers, child to adult; ways to respond to writing, and the organization of the classroom for the teaching of writing. Persons taking the course will need to have access to students to carry out course requirements. Prereq: permission. 4 cr.

**734. CHILDREN'S LITERATURE**

Interpretive and critical study of literature for children in the elementary, middle, and junior high schools. Methods of using literature with children. 4 cr.

**750. INTRODUCTION TO EXCEPTIONALITY**

Survey of the social, psychological, and physical characteristics of exceptional individuals including intellectual (gifted, retarded, learning disabled); sensory (visual, auditory); motor (orthopedic); health; and communication exceptionalities. Implications for educational and human service delivery. 4 cr.

**751. EDUCATING EXCEPTIONAL LEARNERS**

Issues in special education (labeling, mainstreaming, efficacy); techniques of special teaching (referral, assessment, observation, task analysis, profiling, selecting materials, intervention); and issues in special teaching (behavior modification, ability training). Primary application to mild and moderate exceptionalities. Co- or prereq: Educ 750 or permission. 4 cr.

**752. DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITIES**

Terminology, etiology, common characteristics, and symptoms; theory and practice in gross-motor, visual, and auditory remediation; testing procedures used in diagnosis and remediation programs. 4 cr.

**753. TEACHING CHILDREN WITH BEHAVIOR DISORDERS**

Nature and scope of emotional disturbances and social maladjustments in children, including causes, characteristics, treatment implications, and educational problems. 4 cr.

**755-756. DIAGNOSTIC-PRESCRIPTIVE TEACHING OF EXCEPTIONAL LEARNERS**

A two-semester course to develop teacher competence to analyze learners and learning environments, specify learner characteristics, and prescribe, implement, and evaluate special educational interventions. Applications in the areas of language, mathematics, reading, science, social studies, perceptual-motor, behavioral, adaptive, and social skills. Focus on mildly and moderately handicapped children in regular class and resource room. Prereq: Education 750, and 751 or 700J, 703I, or permission. 4 cr.

**760. INTRODUCTION TO YOUNG CHILDREN WITH HANDICAPS**

The needs of children (birth to eight years) with handicaps or who are at-risk for handicaps.

Strengths and special needs of handicapped children; causes, identification, and treatment; current legislation; parent and family concerns; program models. 4 cr.

**763. INTRODUCTION TO EDUCATIONAL MEDIA**

Educational media in the learning process; curricular integration of materials and equipment in the school library media center; design and implementation of learning systems that provide a framework for the development of individual skills. 4 cr.

**764. TELEVISION AND THE YOUNG CHILD**

The emergence of television as a cultural force and its affect upon the development of the young child—physically, socially, emotionally, and intellectually. Working with parents, teachers, and children to help them become better television consumers and planning alternatives for utilizing the technology of television more positively. Knowledge of some of the many research studies conducted and in process expected. 4 cr.

**775. DIAGNOSTIC TEACHING OF READING**

Classroom implementation of diagnosis and remediation of reading disabilities; for teachers, counselors, administrators, and other school personnel. 4 cr.

**776. READING FOR CHILDREN WITH SPECIAL NEEDS**

Techniques and procedures for teaching reading to children with special learning needs: the mentally retarded; learning disabled; gifted, culturally diverse. Emphasis will be placed on the implications of providing reading instruction in the least restrictive alternative. 4 cr.

**785. EDUCATIONAL TESTS AND MEASUREMENTS**

Theory and practice of educational evaluation; uses of test results in classroom teaching and student counseling; introductory statistical techniques. 4 cr.

**797. SEMINAR IN CONTEMPORARY EDUCATIONAL PROBLEMS**

Issues and problems of special contemporary significance, usually on a subject of recent special study by faculty member(s). Prereq: permission. May be repeated for different topics. 1-4 cr.

**800, 801. INTERNSHIP AND SEMINAR IN TEACHING**

A two-semester, full-time, supervised internship consisting of less-than-full teaching responsibility in selected educational settings and programs. Weekly seminars and occasional workshops held concurrently with internship. Admission by application. 2-6 cr.

**806. APPROACHES TO LANGUAGE ART INSTRUCTION**

Analysis of current research and trends. Language development and literature, including contributions of allied disciplines such as semantics and linguistics. Focus on processes of communication and application to school curriculum. 4 cr.

### **807. FOUNDATIONS OF READING INSTRUCTION**

Survey of reading process, theoretical models, and basic approaches to the teaching of reading. Emphasis on current methods, materials, and programs. 4 cr.

### **808-809. CLINICAL DIAGNOSIS AND REMEDIATION OF READING DIFFICULTIES AND DISABILITIES**

Examination of theories and procedures for the diagnosis and remediation of moderate to severe disabilities in reading through case studies, discussions, demonstrations, and practice. Each semester involves a clinical experience. Prereq: Educ 807, 810 or permission. 4 cr.

### **810. COMPREHENSIVE READING METHODS IN THE SECONDARY SCHOOL**

The nature of the reading process, diagnostic and developmental methods and materials, study skills, and reading in the content areas at the secondary level. Designed for secondary school teachers who wish to foster continuous development of students' reading and study skills. 4 cr.

### **813. FIELD PRACTICUM**

Field-based experience focusing on roles of the reading specialist in the school setting. Prereq: permission. 4 cr.

### **814. SEMINAR IN READING**

Investigation of current research findings in reading and the related language arts. Seminars will focus on significant research projects, program designs, and analysis of the field of reading research and ramifications for the reading specialist. Prereq: permission. 4 cr.

### **815. READING AND THE ADULT LEARNER**

Current practices in teaching adults to read; the reading process and adult cognitive development; development of literacy in a technological society. A major portion of the course work will involve a case study in which students will examine an extant program or develop a new course of study that addresses a particular need in adult reading education. Prereq: permission. 4 cr.

### **817. PROFESSIONAL SEMINAR IN REHABILITATION**

Analysis and discussion of current and future trends, issues, and problems; clinical and professional practices; and research and research utilization in developing service programs in rehabilitation. Prereq: permission. 4 cr.

### **818. PRINCIPLES AND PROCEDURES IN REHABILITATION**

Introductory course integrating theory and practice in the field of rehabilitation. History and philosophy of rehabilitation as a social movement, including relevant legislation. Study of institutions. Role, function, and work of the counselor. Relation of the rehabilitation process to the total health and helping service delivery systems. Prereq: permission. 4 cr.

### **819. SOCIAL AND PSYCHOLOGICAL ASPECTS OF DISABILITY**

Examination of historical and cultural concepts of human deviance and disability. Analysis of social, psychological, and vocational factors resulting from disabling and disadvantaged human conditions. Relationship of rehabilitation to disability and to individual adjustments. Field-based consultation with disabled individuals and rehabilitation agencies. Simulated, eight-hour disability project for each student. Prereq: permission. 4 cr.

### **820. COUNSELING THEORY AND PRACTICE**

Basic approaches to counseling are examined—their theoretical foundations, process components, goals, and outcomes. 4 cr.

### **821. PSYCHOLOGY OF CAREER AND PERSONAL DEVELOPMENT**

Career and personal development and how each influences the other; literature and research examined to clarify application to individual and group career-counseling and to career education. 4 cr.

### **822. ASSESSMENT IN COUNSELING**

Evaluative instruments and methods that have particular use in counseling. Systematic procedures for measuring samples of an individual's behavior and statistical concepts that underlie psychological testing. Assessment is viewed from the perspective of its use in the counseling process as well as its use in accountability. 4 cr.

### **823. GROUP COUNSELING**

Theoretical and applied dimensions of the group counseling process. Class may include laboratory experience to examine one's interactive behavior as a group member and leader. Prereq: Educ 820; permission. 4 cr.

### **824. PSYCHOLOGICAL STRESS AND ADAPTATION**

Problems in stress that are significant for human adaptation. Behavior patterns which pose the most common problems encountered by contemporary counselors are reviewed, with emphasis upon the concepts and processes of adaptation. 4 cr.

### **825. COUNSELING INTERNSHIP I**

Introductory supervised field experience focusing on the integration of counseling theory and practice, including laboratory microcounseling and seminars in contemporary professional issues. Interns select an approved field placement reflecting their professional interests. Prereq: permission. 4 cr.

### **826. COUNSELING INTERNSHIP II**

Supervised counseling at approved field site. Opportunities also provided for involvement in consultative, evaluative, and other organizational procedures. Focus is on critiques of audio/video samplings of intern's counseling. Prereq: permission. 4 cr.

### **827. ADMINISTRATION OF COUNSELING SERVICES**

Organizational patterns and administrative procedures that influence the effectiveness of counseling services. Emphasis upon staff development, accountability, professional issues, and productive supervisory behaviors. Prereq: permission. 4 cr.

**828. ADVANCED COUNSELING THEORY AND PRACTICE**

Detailed analysis of the counseling relationship: its characteristics, processes, and outcomes. Prereq: permission. 4 cr.

**829. ADVANCED COUNSELING INTERNSHIP**

Supervised application of advanced counseling theory and practice in counseling relationships. Samplings of the advanced counseling practices of students will be analyzed and evaluated. Open only to C.A.G.S. candidates in UNH graduate program in counseling. Prereq: Educ 828; permission. 4 cr.

**830. RESEARCH IN COUNSELING**

Research design and methodology in counseling. Students develop research projects that demonstrate knowledge of research procedures in evaluating the processes and outcomes of counseling. Prereq: permission. 4 cr.

**831. SEMINAR AND PRACTICUM IN ELEMENTARY SCHOOL TEACHING**

Supervised Practicum: Exploratory summer practicum in a local summer elementary school to examine teaching as a career and to prepare for the internship in the fall. Summer includes: 1) a pre-practicum workshop focusing on interpersonal skill development; 2) a prepracticum curriculum and instructional laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching high school students are available for candidates who wish to determine better what level of teaching they prefer. Prereq: admission to the M.A.T. program or M.Ed. program for preservice teachers. 4 cr. (Summer Session only.)

**835. SEMINAR AND PRACTICUM IN SECONDARY SCHOOL TEACHING**

Supervised Practicum: An exploratory summer practicum in a local summer high school to examine teaching as a career and to prepare for the internship in the fall. Summer includes: 1) a pre-practicum workshop focusing on interpersonal skill development; 2) a prepracticum curriculum and instructional laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching on elementary level are available for candidates who wish to determine better what level of teaching they prefer. Prereq: admission to the M.A.T. or M.Ed. programs for preservice teachers. 4 cr. (Summer Session only.)

**841. CHILD DEVELOPMENT FOR THE EARLY CHILDHOOD PROFESSIONAL**

To understand child growth; components of the course involve students in extended contacts with significant adults related to children in an early learning environment. Includes home visits to interview parents and other relatives, and to observe the child in the family setting. Extensive readings, discussions, case study models, film viewings, and continued in-depth child study. Prereq: previous experience with young children. 4 cr.

**843. ENVIRONMENT FOR EARLY CHILDHOOD**

Examination of various environments with attention to use of time, space, and materials. Study of multiple professional roles needed in providing appropriate Learning Center adjustments to maximize individual child development. 4 cr.

**845. PROGRAMMING FOR SEVERELY/MULTIPLY HANDICAPPED YOUNG CHILDREN**

Information and suggestions for working with the severely and/or multiply handicapped child, ages birth to eight. Emphasis will be on individualized program planning, particularly developmental and multidisciplinary approaches. Prereq: permission. 4 cr.

**846. ASSESSMENT IN EARLY CHILDHOOD**

Study, administer, and design a range of assessment materials. Develop strategies for selection and utilization of clusters of assessment materials. Collect and organize relevant data. Prereq: Educ 841; Educ 843. 4 cr.

**847. DIAGNOSIS AND EDUCATIONAL PLANNING FOR YOUNG HANDICAPPED CHILDREN**

Focus on information and practical experiences relating to assessment and remediation of developmental handicaps in children from birth to eight years old. Formal and informal criterion-referenced assessment, individualized education plans, multidisciplinary approaches, parental roles, report writing. Prereq: Educ 760, 841, or equivalent. 4 cr.

**848. CONTEMPORARY INFLUENCES UPON EARLY CHILDHOOD EDUCATION**

Survey of contemporary models in early childhood education in this country and consideration of current issues having an influence on young children. Application of principles to individual student and specific early learning situations. Prereq: current involvement with a specific group of children. 4 cr.

**849. SUPPORTING PARENTS OF YOUNG HANDICAPPED CHILDREN**

Social, economic, and psychological consequences of raising a child with a handicapping condition. Issues will include diagnosis and prognosis for the child, parent-child attachment, and interactions with other care givers. Counseling and support techniques. 4 cr.

**850. FOUNDATIONS OF EARLY CHILDHOOD EDUCATION**

Historical roots of contemporary practices. Perspective of historical precedents in content, methodology, and change. Study and review of child development, assessment, classroom environments. Prereq: Educ 841; 843; 846; and 848. 4 cr.

**851. LAWS AND REGULATIONS AFFECTING THE EDUCATION OF HANDICAPPED CHILDREN**

Analysis of current federal and state policies affecting handicapped children. Focus will be on Public Law 94-142. The role of policy making and constitutional and ethical issues will be discussed. 4 cr.

### **853. SEMINAR IN CURRICULUM STUDY**

Analysis of recent trends in public school curriculum; structures, philosophy, development, change, and evaluation. Primarily for experienced teachers and administrators. Prereq: teaching experience. 4 cr.

### **854. SURVEY OF DEVELOPMENTAL DISABILITIES**

Mental retardation, cerebral palsy, epilepsy, autism, and related handicapping conditions; causal factors, physical and psychological characteristics, educational and therapeutic implications. Observations of programs and services for the developmentally disabled are required. 4 cr.

### **855. SERVICE DELIVERY SYSTEMS IN DEVELOPMENTAL DISABILITIES**

Service delivery system models in developmental disabilities; pre- and postnatal, preschool, elementary, secondary, postschool, institutional, and adult occupational. Examination of plans for the provision of services and facilities for the developmentally disabled; administrative, social, legal, and educational implications. 4 cr.

### **856-857. FIELD PRACTICUM AND SEMINAR IN DEVELOPMENTAL DISABILITIES**

One semester of supervised experiences in a diversity of agencies and facilities serving the developmentally disabled; a one-semester experience in a setting approximating the student's career choice; biweekly seminars on topics related to the delivery of service to the developmentally disabled. Prereq: permission. 8 cr.

### **858. ANALYSIS OF TEACHING**

Comparative analysis of current techniques and instrumentation for studying the process of teaching in the classroom. Consideration of substantive and procedural issues involved in planning for teaching. Prereq: teaching experience. 4 cr.

### **861. PUBLIC SCHOOL ADMINISTRATION**

Introductory course; major issues in policy making, school management, personnel, public relations, finance, and research in school administration. Prereq: teaching experience. 4 cr.

### **862. EDUCATIONAL FINANCE AND BUSINESS MANAGEMENT**

Principles of financing education, budgetary procedures, accounting, auditing, school indebtedness, financial reporting, and business management. Handling practical school finance problems will be part of the project work. Prereq: Educ 861. 4 cr.

### **863. SEMINAR IN EDUCATIONAL ADMINISTRATION**

Cases and concepts in educational administration. Prereq: Educ 861. 4 cr.

### **864. PERSONNEL AND COMMUNICATION IN EDUCATIONAL ORGANIZATIONS**

Problems arising from the communications process. Implications of group problem-solving processes. Interpersonal relations and group dynamics among students, faculty, staff, administration, and the community. Application of theories. 4 cr.

### **865. EDUCATIONAL SUPERVISION**

Theoretical foundations of supervisory behavior as a means of effecting changes in instructional practices; consideration of instruments and techniques based on those theoretical foundations; some opportunity for field projects utilizing instruments and techniques. Prereq: teaching experience. 4 cr.

### **866. PRACTICUM IN SUPERVISION AND CURRICULUM**

Supervision of teaching and curriculum development projects in the schools. Opportunity to apply skills in supervising and curriculum development techniques. Prereq: Educ 853; Educ 865; permission. 4 cr.

### **867. LEGAL ASPECTS OF SCHOOL ADMINISTRATION**

Relationship of law to public education. Emphasis on federal constitution, New Hampshire statutes, and case law related to public interests served by elementary and secondary education. Special topics: church-state relationship, due process, desegregation, state agencies, supervisory unions, school districts, school boards, teacher employment, negotiations, student rights, tort liability, school finance. Prereq: Educ 861; Educ 863. 4 cr.

### **868. COLLECTIVE BARGAINING IN PUBLIC EDUCATION**

An examination of collective bargaining as practiced by school boards, administrators, and teacher organizations. Consideration will be given to collective bargaining statutes, case law, employee relations boards, unit determinations, exclusive representation, union security provisions, scope of bargaining, good faith, grievance procedures, bargaining strategies, strikes, public interest, mediation, factfinding, arbitration, and the administration of the negotiated contract. Prereq: Educ 863. 4 cr.

### **869. PRACTICUM IN EDUCATIONAL ADMINISTRATION**

Supervised practical experience in dealing with problems in educational administration. Prereq: Educ 863. 4 cr.

### **870. THE CHANGE PROCESS IN EDUCATION**

Role of change agent and the change process in education as related to school personnel; structural characteristics of the school culture; change theory and systems analysis techniques. Students will be required to apply some of the theories in an institutional setting. 4 cr.

### **871. SCHOOL PLANT PLANNING**

A study will be made of the techniques and procedures involved in the long-range planning of school facilities; for example, school populations projections, characteristics of the educational program, space requirements, evaluation of existing facilities, future use of existing buildings, analysis of financial resources available, identification of reasonable alternatives, and an examination of the probable consequences of such alternatives, including educational effectiveness and tax impact. Prereq: Educ 863 or permission. 4 cr.

**872. EDUCATIONAL PROGRAM EVALUATION**

Selected models for educational program evaluation; rationale underlying these models examined and compared; practical applications developed. Each student will plan a complete evaluation design for an appropriate educational program. Prereq: Educ 853; Educ 861; /or permission. 4 cr.

**874, 875. ADMINISTRATIVE INTERNSHIP AND FIELD PROJECT**

Field-based internship. Administrative experiences in one or several educational and community agencies. Participation in administrative and supervisory work of the agencies. Each intern completes a major field project requiring analysis and action appropriate for resolution of a significant administrative problem at the intern site. Supervision by University faculty. Prereq: permission of graduate adviser. A grade of credit (CR) will be given upon successful completion of the internship and field project. 6 cr.

**880. RESEARCH IN THE TEACHING OF WRITING**

Review of the last 30 years of research in writing, focusing on trends in design, research procedures, the contributions of linguistics, cognitive and developmental psychology, with a view to the conduct of research by participants. Prereq: permission. 4 cr.

**881. METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH**

Conceptual aspects and practical realities of the research process applied to problems in education and human service disciplines. Develops skills necessary to use as well as conduct research. 4 cr.

**883. ADVANCED PSYCHOLOGY OF HUMAN LEARNING**

Review and integration of learning theory, teacher effectiveness, motivation theory, and development through adolescence; application of these to teaching generally and to the areas of specialization of the participants. Prereq: Educ 701 or equivalent. 4 cr.

**884. ADVANCED HUMAN DEVELOPMENT**

Selected principles and skills humankind must consider in the attempt to maximize individual, social, and educational potential; emphasis on personal implementation. Prereq: Educ 701, intro to psych, or equivalents. 4 cr.

**886. PHILOSOPHY OF EDUCATION**

Seminar in comparative analysis of contemporary educational objectives and practices and the philosophical foundations upon which they are based. Application of theoretical criteria for assessing educational philosophies and for developing one's own position. 4 cr.

**890. DEVELOPMENTAL PERSPECTIVES ON ADULTHOOD**

Research and theory about critical life issues; developmental tasks of the life cycle; periods of transition; stages of intellectual, moral, and personality development of the adult; and the design of significant learning experiences for adults within a variety of educational settings and institutions. 4 cr.

**895. INDEPENDENT STUDY IN EDUCATION**

Opportunity for intensive investigation of a special problem or issue in the field of education. Prereq: permission. 1-4 cr. May be repeated to a maximum of 8 cr.

**899. THESIS**

Prereq: permission of the department. 6-10 cr.

*Related course in the School of Health Studies (SHS), Department of Occupational Therapy*

**OT701. MANAGING RESOURCES FOR THE DEVELOPMENTALLY DISABLED**

Analysis and application of various administrative techniques, processes, and systems used in delivering services to developmentally disabled persons. Professional teamwork examined via case discussions, class exercises, and site visits. Prereq: permission. 4 cr.

**Electrical and Computer Engineering (EE)**

**Chairperson:** Ronald R. Clark

**PROFESSORS:** Fletcher A. Blanchard, Jr.; Ronald R. Clark; Albert D. Frost; Joseph B. Murdoch; John L. Pokoski; Alden L. Winn

**ASSOCIATE PROFESSORS:** Glen C. Gerhard; Filson H. Glanz; Donald W. Melvin; Paul J. Nahin; Kondagunta Sivaprasad

**ASSISTANT PROFESSORS:** L. Gordon Kraft; John R. LaCourse; Walter T. Miller III

**GRADUATE PROGRAM COORDINATOR:** Kondagunta Sivaprasad

A student admitted to graduate study in electrical engineering should have completed a baccalaureate degree in electrical engineering or have comparable training, which included courses in mathematics and physical science, network theory, fields and waves, electronics, solid state circuits, semiconductor device theory, with appropriate laboratory experiences.

A minimum of 24 credits of coursework plus 6 credits of thesis or project are required for the master's degree. No specific course requirements are mandated; each candidate will meet with the departmental graduate committee to set up a program of study. Students are further required to demonstrate the ability to do independent and creative work by taking either E E 899 or 891-892. With the consent of the Graduate Committee, a student who has satisfied this requirement through industrial experience may substitute approved coursework.

E E 899 and 891-892 both involve equivalent independent theoretical and/or applied work under the guidance of a faculty member. The sequence 891-892 is to be completed in two consecutive semesters, with a letter grade given at the end of each semester. An interim report is submitted at the end of 891, and a final (oral and written) report at the end of 892. E E 899 requirements include the submission of a formal thesis suitable for binding. However, no two-semester time limit is imposed, and no interim or final letter grade is given.

Those who intend to undertake graduate work in electrical engineering must consult with the department graduate adviser in order to plan the program of study, since all courses are not given each year. Normally, a minimum of 12 credits of 800-level courses is required, not including 891-892 or 899.

The Electrical and Computer Engineering Department considers the development of professional communication skills, through a teaching assignment, a basic component of a graduate education. Every master's candidate is required to satisfactorily complete one year of E E 800 seminar; participation includes presentations as needed to satisfy the teaching requirements.

An interdepartmental Engineering Ph.D. Program is also available in the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. Electrical engineering students would normally work in one of the first two areas. For details refer to the section entitled Engineering Ph.D. Program.

Since many graduate courses are given by demand, actual course offerings vary from semester to semester.

### **Areas of Specialization**

The faculty of the Electrical and Computer Engineering department has research interests in the following areas. Students in the M.S. Electrical Engineering or the Engineering Ph.D. program may select courses and research topics in these areas.

#### **Biomedical and Clinical Engineering**

Topics of study in these areas include biomedical instrumentation, computer applications to medical problems, patient safety, direct patient care, health delivery systems, and applications of signal processing and instrumentation techniques to medical areas.

A specialization in either of these areas may be elected by the student. Students specializing in Biomedical Engineering must complete E E 783, 784, and 836 plus approved professional electives. Students in Clinical Engineering, in addition to the courses listed above, complete one year of internship in the Clinical Engineering Lab (E E 833-834). Additional details are available upon request.

#### **Communications Systems and Information Theory**

Areas of interest and activity include electromagnetic and acoustic wave technologies, and the identification of signals in the presence of noise through the use of coding, correlation, or optimal filtering. Related facilities for experiments extending from VLF to microwaves are available at a roof-top communications system for space, terrestrial, and ocean applications.

#### **Computer Engineering and Digital Systems**

Theoretical aspects of switching theory; systems that recognize patterns, learn, and exhibit intelligence; application of switching logic, design and interfacing of minicomputer peripherals; application of minicomputers to process control and bioclectronics. The Digital Systems Laboratory includes four minicomputers with magnetic tape

units, teletype terminals, high speed paper tape units, AD and DA converters, graphics output, and interconnect capability with a TR-48 analog computer.

#### **Control and Systems Engineering**

Digital, hybrid, and analog computer control of industrial processes and systems. Discontinuous and fluidic control theory for industrial, marine, and oceanographic applications. Linear and stochastic analysis, synthesis techniques in the frequency domain, optimal control, and systems optimization.

#### **Geophysical Sensing and Propagation**

Ground-based electromagnetic techniques for probing of upper atmosphere and the ionosphere; electromagnetic pulse techniques for probing of ice, snow, and other material media. Wave propagation studies in weakly turbulent media such as the sea, the atmosphere, and plasmas. Acoustic probing of bottom and subbottom sediment in water.

#### **Illumination Engineering**

Design techniques for evaluating contrast rendition factor and equivalent sphere illumination; inverse-square-law approximations for nonpoint light sources; design of daylighting systems; hand calculator programs for interior and exterior lighting design; lighting energy budgets.

#### **Ocean Engineering and Instrumentation**

Instrument systems (digital and analog) for measuring and recording physical, chemical, and biological parameters primarily associated with ocean behavior, e.g., temperature, pressure, and salinity measurements at midocean depths; wave height and direction determination; buoy performance as affected by waves and currents; remote sensing of the ocean surface; and underwater acoustics.

**Permission of instructor is required for enrollment in all electrical and computer engineering courses taken for graduate credit. Seven-hundred-level courses are offered subject to adequate student demand.**

### **705. SEMICONDUCTOR DEVICES**

Physical theory of semiconductors: models of solids, electronic properties, energy bonds, and transport processes. PN junction theory; bipolar and field effect transistors; charge-transfer, optoelectronic, and integrated devices; and device fabrication technology. Prereq: gen. physics; adv. electronics, electromag. fields and waves; or equivalent. 4 cr.

### **711. DIGITAL SYSTEMS**

Advanced switching theory techniques; digital design tools; design of microprocessor-based systems; general design procedures, including top-down design techniques, documentation, noise reduction, etc. Prereq: logical design of digital computers; permission. Lab. 4 cr.

### **714. MINICOMPUTER APPLICATIONS ENGINEERING**

Organization and operation of minicomputer-based systems. Interfacing of special purpose peripherals, digital filters, system simulation, pro-

gram and data organization, priority interrupt processing of tasks, real-time monitor systems. Applications to communication, automated-measurement, and process-control systems. Prereq: elements of digital systems or intro to digital systems; programming experience; permission. Lab. 4 cr.

### **727. POWER SYSTEMS**

Modeling and planning of electric power transmission systems. Prereq: electromech devices; electrical networks; permission. 4 cr.

### **741. FLUID CONTROL SYSTEMS**

Mathematical modeling of hydraulic, pneumatic, and fluidic control elements and control systems. Methods for 1) analysis of systems of using gases or liquids as the working fluid; 2) synthesis of the parameters of the control elements used in automatic control systems; 3) design of these systems. (Also offered as M E 741.) 4 cr.

### **745. FUNDAMENTALS OF ACOUSTICS**

Acoustic wave equation for air; laws of reflection, refraction, and absorption; characteristics and measurement of acoustical sources; human perception of sound, loudness, intensity; microphones; acoustical materials; problems in environmental sound control; ultrasonics; architectural acoustics. Prereq: general physics II; differential equations; permission. Lab. 4 cr.

### **757. FUNDAMENTALS OF COMMUNICATION SYSTEMS**

Discussions of deterministic signals, Fourier spectra, random signals, and noise, baseband communication, analog and digital modulation schemes, and system signal to noise ratio. Prereq: electrical networks; permission. Lab. 4 cr.

### **758. COMMUNICATION SYSTEMS**

Design of high-frequency communication systems. RF amplification, modulators for AM and FM systems, receiving techniques, antennas, free-space propagation, propagation characteristics of the ionosphere. Prereq: electromagnetic fields and waves I; E E 757 or equivalent. Lab. 4 cr.

### **762. ILLUMINATION**

Radiation; color and spectra; physics of light production; sources of ultraviolet, visible, and infrared energy; lamp circuitry; control of light; lighting design, applications of light in business, industry, school, home, and outdoors. Open to juniors and seniors in engineering and physics. Lab. 4 cr.

### **775. APPLICATIONS OF INTEGRATED CIRCUITS**

Design and construction of linear and nonlinear electronic circuits using existing integrated circuits. Laboratory course in practical applications of non-digital integrated circuit devices. Prereq: advanced electronics. 4 cr.

### **781. OCEAN INSTRUMENTATION**

Analysis and design of instrumentation systems. Sensors, circuits, and devices for measurement and control. Elements of probability and statistics as applied to instrument design and data analysis. Transmission, display, storage, and processing of information. The design, implementation, testing,

and evaluation of an ocean-related instrument system is an integral part of the course. Prereq: permission. 4 cr.

### **782. CONTROL SYSTEMS**

Fundamental principles involved in the design and analysis of feedback control systems. Topics include stability criterion, time-domain analysis, frequency-domain analysis, and introduction to nonlinear systems. Lab. (Also offered as M E 782.) 4 cr.

### **783. BIOMEDICAL ENGINEERING**

Engineering applied to cardiovascular, renal, gastrointestinal, sensory, reproductive, and other organ systems. Design and utilization of diagnostic, monitoring, and prosthetic techniques and devices. Lab. 4 cr.

### **784. BIOMEDICAL INSTRUMENTATION**

Principles of physiological and biological instrumentation design including transducers, signal conditioning, recording equipment, and patient safety. Laboratory includes the design and use of instrumentation for monitoring of electrocardiogram, electromyogram, electroencephalogram, pulse, and temperature. Current research topics, such as biotelemetry, ultrasonic diagnosis, and computer applications. Lab. 4 cr.

### **785. UNDERWATER ACOUSTICS**

Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small- and large-signal considerations. 4 cr.

### **786. INTRODUCTION TO RADIO ASTRONOMY**

Electromagnetic radiation, propagation. Positional astronomy and the radio sky, discrete radio sources, source-structure distribution, the sun as a radio source, flare and burst activity, planetary emissions, quasars, pulsars, techniques of observation and data reduction, radiometry, polarimeters, correlation interferometers, aperture synthesis. 4 cr.

### **787. HUMAN PHYSIOLOGICAL CONTROL SYSTEMS**

Analysis of human physiological control systems and regulators through the use of mathematical models. Identification and linearization of systems component. Membrane biophysics; system interactions, stability, noise and the relationship of system malfunction to disease. 4 cr.

### **796. SPECIAL TOPICS IN ELECTRICAL ENGINEERING**

New or specialized courses and/or independent study. 2 or 4 cr.

### **800. GRADUATE SEMINAR**

This course includes periodically scheduled seminars presented by outside speakers, UNH faculty, and graduate students. Topics will be in general areas of interest to electrical and electronics engineers. Participants will prepare and give presentations to satisfy teaching practice requirements. 0 cr. Cr/F.

**801. ELECTROMAGNETIC FIELD THEORY**

Maxwell's equations; plane wave propagation; reflection and refraction; guided wave propagation; wave guides; simple resonators; elements of microwave circuits, linear and aperture antennas, arrays of dipoles; receiving antennas. Prereq: electromagnetic fields and waves I or equivalent. 3 cr.

**802. ELECTROMAGNETIC WAVE THEORY**

Selected advanced topics in electromagnetic wave theory taken from such areas as: antennas; propagation in various media; diffraction and scattering; microwave generation and waveguide propagation. Prereq: E E 801. 3 cr.

**811. FUNDAMENTALS OF SIGNAL PROCESSING**

Matrices and determinants, introductory graph theory. Laplace transforms and pole-zero concepts, complex variable theory, convolution, concept of state, formulation and solution of state equations. 3 cr.

**812. FILTER DESIGN AND SYNTHESIS**

Network theoretical techniques basic to the design of electrical filters of various sorts. Approximation theory; driving point and transfer synthesis techniques; passive, active, and digital filters. Prereq: E E 811. 3 cr.

**815. ADVANCED ACTIVE CIRCUITS**

Investigation of devices and techniques used in advanced circuit design using discrete solid-state devices and integrated circuits. Oscillators, phase-locked systems, low noise techniques, etc. 3 cr.

**820. ILLUMINATION DESIGN**

Advanced illumination design; task visibility levels, bidirectional reflectance factors, contrast rendition factor, equivalent-sphere illumination, visual performance criteria, visual comfort probability, day-lighting systems, inverse-square-law approximating techniques, luminaire effectiveness, and lighting energy budgets. Students write computer programs and lighting design projects. Prereq: E E 762 or equivalent experience. 3 cr.

**833-834. PRACTICUM IN CLINICAL ENGINEERING**

Seminars in medical equipment management; evaluation, testing, and standards; working experience in laboratory and in community hospitals in conjunction with the Clinical Engineering Center. Prereq: permission of instructor and director of CEC. A year-long continuous course; 3 credits each semester. "IA" grade (continuous course) will be given at the end of the first semester. 3 cr.

**836. BIOMEDICAL ENGINEERING II**

Applications of engineering in such areas as surgery, critical-care units, neurophysiology, biotelemetry, modeling, and interaction of waves with biological tissues. Prereq: E E 783 or equivalent. 3 cr.

**839. STATISTICAL THEORY OF COMMUNICATIONS**

An introduction to probability theory and random waveforms leading to a discussion of optimum receiver principles. Topics include random variables, random processes, correlation, power spectral den-

sity, sampling theory, and optimum decision rules. 3 cr.

**840. INFORMATION THEORY**

A continuation of E E 839. Introduction of information-theory concepts. Topics include: message sources, entropy, channel capacity, fundamentals of encoding, Shannon's theorems. Prereq: E E 839. 3 cr.

**841. DIGITAL SIGNAL PROCESSING**

Theory and practice of digital signal processing; elements of nonrecursive and recursive digital filters, random number generators and simulation of time series, the fast Fourier transform, spectral estimation, envelopes and phases, modeling of time series. Samples of data from various physical experiments will be analyzed as student projects. Some exposure to programming is desirable. 3 cr.

**842. DISCONTINUOUS CONTROL**

Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods that use the quantized nature of the information are also developed. Design methods for pulse-width modulation, optimum quantizers and limit cycle behavior of quantized systems are developed. (Also offered as M E 842.) 4 cr.

**844. NONLINEAR CONTROL SYSTEMS**

Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: E E 851. (Also offered as M E 844). 4 cr.

**851. ADVANCED CONTROL SYSTEMS I**

State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Luenberger observers. Introduction to computer controlled systems (sampling, discrete state representation, hybrid systems), nonlinear analysis (Liapunov, Popov, describing function). Prereq: E E/M E 782. (Also offered as M E 851.) 3 cr.

**852. ADVANCED CONTROL SYSTEMS II**

Special topics in control theory: continuous and discrete systems; optimal control systems, including calculus of variations, maximum principle, dynamic programming, Weiner and Kalman filtering techniques, stochastic systems, adaptive control systems. Prereq: E E/M E 851. (Also offered as M E 852.) 3 cr.

**853. ARTIFICIAL INTELLIGENCE**

Current approaches to machine intelligence and the simulation of human cognitive processes, including an introduction to recursive functions and programming with the LISP language. Heuristic programming, programs for game playing and natural language understanding, elementary theory of computability. Individual computer project required. Prereq: programming experience. (Also offered as C S 853.) 3 cr.

#### **854. AUTOMATA THEORY**

Formal languages and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as C S 854.) 3 cr.

#### **855. ESTIMATION AND FILTERING**

Stochastic systems course with application to control and communications. Topics include random variables, noise in linear systems, Bayesian and minimum variance estimation theory, optimal state estimators, Weiner and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: M E/E E 851, Math 735 or equivalent. (Also offered as M E 855.) 3 cr.

#### **856. SWITCHING THEORY**

Combinational circuits—including functional decomposition, nonbinary logic, and cellular networks. Sequential networks—including analysis, transient behavior, state reduction methods, state assignment, and synthesis. Prereq: E E 711. 3 cr.

#### **860. COMPUTER ARCHITECTURE**

Advanced topics in computer organization. Parallel and pipeline processing; associative and stack computers; microprogramming; virtual memory; current topics. Prereq: logical design of digital computers. 3 cr.

#### **865. INTRODUCTION TO PATTERN RECOGNITION**

Machine classification of data, feature space, clustering, linear separability, fictitious play algorithm, Braverman's hyperplane training and learning algorithm, learning and game playing computer programs that recognize patterns. Prereq: knowledge of computer terminal operation; BASIC language; probability and statistics or equivalents. 3 cr.

#### **891-892. RESEARCH**

3 cr.

#### **898. INDEPENDENT STUDY**

Independent theoretical and/or experimental investigation of an electrical engineering problem under the guidance of a faculty member. 1-3 cr.

#### **899. MASTER'S THESIS**

6 cr.

## **Engineering Ph.D. Program (Engr)**

PROFESSORS: Paul L. Bishop; Fletcher A. Blanchard, Jr.; Ronald R. Clark; Robert W. Corell; Stephen S. T. Fan; Stephen L. Fink; Albert D. Frost; Shan S. Kuo; Joseph B. Murdoch; John L. Pokoski; Godfrey H. Savage; Linda G. Sprague; Charles K. Taft; Gail D. Ulrich; Tung-Ming Wang; Robin D. Willits; Alden L. Winn; Asim Yildiz

ASSOCIATE PROFESSORS: E. Eugene Allmendinger; Wendell S. Brown; Barbaros Celikkol; Pedro A. DeAlba; Ihab H. Farag; Glen C. Gerhard; Filson H. Glanz; Charles H.

Goodspeed; David L. Gress; Louis H. Klotz; David E. Limbert; Virendra K. Mathur; Donald W. Melvin; William Mosberg; Paul J. Nahin; Paul J. Ossenbruggen; Kondagunta Sivaprasad; Donald C. Sundberg; M. Robinson Swift; Russell L. Valentine; John A. Wilson

ASSISTANT PROFESSORS: Yen-hsi Chu;

Robert M. Henry; Gary W. Jaworski;

L. Gordon Kraft; John R. LaCourse;

Walter T. Miller III

ENGINEERING PH.D. COMMITTEE:

Stephen S. T. Fan; Kondagunta Sivaprasad;

Charles K. Taft; Tung-Ming Wang

The interdepartmental engineering program offers graduate work leading to the degree of Doctor of Philosophy and is conducted by a combined engineering faculty. The program consists of areas of specialization within an interdepartmental structure, depending principally upon strengths in engineering, the engineering sciences, mathematics, and the physical sciences. An interdepartmental program is felt to be most meaningful since many contemporary engineering and scientific problems can be solved only through the cooperation of a variety of disciplines. Further, the boundaries between the classical disciplines in engineering and science have become less distinct. The particular advantage of the nondepartmental program structure is that improved communication and cooperation develop among faculty and students of the different disciplines, resulting in more meaningful academic and professional experiences.

#### **Areas of Specialization**

The Engineering Ph.D. program includes the following four areas of specialization.

**Engineering Systems Design:** Charles K. Taft, chairperson

Students entering this area of the Engineering Ph.D. Program can elect either one of two professional directions. The first seeks to develop professionals with the technical expertise of a Ph.D. and with the ability to work with and direct groups of people working on large-scale technical projects. The second direction seeks to develop engineers with capabilities in the theory and analysis of large-scale complex systems. Concentration in an area of specific individual interest is combined with participation in a larger interdisciplinary project.

Current projects related to the area include coastal engineering, marine soil mechanics, submersibles and underwater habitats, ocean instrumentation, marine structures and buoy systems, arctic engineering, discontinuous control systems, vehicle and transportation systems, nonlinear dynamic systems modeling, fluid power systems, nonlinear decoupling control, computer systems, vehicle dynamics, societal systems, facility systems, social and business systems, biomedical systems and instrumentation, and environmental engineering.

**Signal Processing:** Kondagunta Sivaprasad, chairperson

This area of specialization is concerned with those analytic and experimental techniques that are involved in some aspect of the acquisition, detection, identification, analysis, or control of signals. In this context a signal is defined as any quantity which contains or conveys information. While the majority of signal processing systems are partially

or wholly electrical in nature, many of the basic aspects of signal processing and utilization are common to a wide range of problems and applications in communications, medicine, environmental modeling, instrumentation, and control.

The development of professional communication skills, through a teaching assignment, is considered a basic component of a graduate education. Every doctoral candidate in Signal Processing is required to satisfactorily complete one year of E E 800 seminar; participation includes presentations as needed to satisfy the teaching requirements.

Current research areas include: acoustics, biomedical systems and instrumentation, computer and digital systems, digital signal processing, em wave propagation, energy and power systems control, fluidics, geophysical sensing, lighting design, nonlinear interacting system control, signal propagation, and systems modeling.

**Theoretical and Applied Mechanics:** Tung-Ming Wang, chairperson

Treated as an engineering science, this area brings together those aspects of engineering, physics, and applied mathematics that are relevant to the understanding and application of the dynamical and equilibrium behavior of materials and structures. Included are the fields of solid mechanics, structural mechanics, classical and continuum mechanics, rheology, hydrodynamics, soil mechanics, systems analysis, elastodynamics, and acoustics.

Current research topics include macro- and micro-mechanics of composite-material behavior, wood-fiber mechanics, viscoelastic material properties, structural dynamics, dynamics of ocean structures, structural optimization, elastodynamics, elastic wave propagation, scattering of elastic waves, electromagnetic wave propagation, structural systems, soil dynamics, nonlinear dynamics, ocean engineering, ocean subbottom resources, oceanography, acoustic determination of the properties of layered media, Cosserat fields, dislocation theories, random vibrations, and estuary hydrodynamics.

**Transport Phenomena:** Stephen S. T. Fan, chairperson

This area deals with the subjects of fluid mechanics, heat transfer, mass transfer, and coupled phenomena in such areas. In addition to their fundamental role in traditional engineering activities, transport-phenomena studies are making significant contributions in many other areas such as energy production and utilization, environmental control, oceanography, space exploration, and biomedical engineering.

Current research activities include solar energy, new energy sources, pollution control, biomedical engineering, combustion, adsorption, heat transfer with phase change, liquid pumping cavitation, vortex flow, coal liquefaction, particle formation, radiative heat transfer, and polymer processing.

## Requirements

Qualified students with bachelor's or master's degrees in engineering, mathematics, or the physical sciences are eligible for admission to the program. To be admitted, students must present evidence that they have sufficient background in the area in which they propose to specialize.

Following entrance into the program, a guidance committee will be appointed for the student by the

dean of the Graduate School upon recommendation of the chairperson of the student's area. This committee assists students in outlining the program and in preparing for the qualifying examination and may require them to take specified course work, with or without credit. The committee will also conduct an annual in-depth review of a student's progress, through written and/or oral examinations, and following the substantial completion of a student's coursework, will administer the qualifying examination. This committee is also responsible for administering any language examination and/or research tool proficiency requirements that are required of the area of specialization.

Upon the successful completion of the qualifying examination and other proficiency requirements, a doctoral committee will be appointed by the dean of the Graduate School upon the recommendation of the chairperson of the student's area. The doctoral committee shall conduct an annual review of the student's progress, supervise and approve the doctoral dissertation, and administer the final examination.

To obtain a Ph.D. degree in engineering, a student must meet all of the general requirements as stated under Regulations of the Graduate School. A student will normally be required to either demonstrate the ability to read scientific and technical literature in an approved foreign language or demonstrate a facility in one or more special "tool of research" techniques. Depending on their educational objectives, students may also be required by the guidance committee to undertake a classroom teaching experience. To complete the Ph.D. degree in engineering students will normally be expected to take coursework equivalent to two full-time academic years beyond the baccalaureate and to complete a dissertation that will require at least one full-time year of study and original research. Specific course requirements have been established for each area of specialization. All these requirements should normally be completed by the end of the second year of full-time graduate study, and must be completed before the student can be advanced to candidacy.

## Course Requirements

Coursework requirements will be developed on an individual basis by each student's guidance committee. Since each area of specialization has its own specific course requirements, interested students should contact the area chairperson to determine the particular coursework and research activity that may be applicable to their educational goals.

Except for Doctoral Research (999), students will follow a program of study consisting of courses from within the chemical, civil, electrical, and mechanical engineering departments, many of which have been established particularly for this program, and from related departments appropriate to students' needs. A student should consult specific course offerings and descriptions.

## English (Engl)

**Chairperson:** Carl Dawson

**PROFESSORS:** Thomas A. Carnicelli; Carl Dawson; Michael V. DePorte; Karl C. Diller; Robert Hapgood; Jean E. Kennard; Gary H. Lindberg; Terence P. Logan; Edmund G. Miller; Donald M. Murray; Philip L. Nicoloff;

John C. Richardson; Charles D. Simic; Mark R. Smith; Thomas A. Williams, Jr.; John A. Yount

ASSOCIATE PROFESSORS: Elizabeth Hageman; Andrew H. Merton; Hugh M. Potter III; Susan Schibanoff

ASSISTANT PROFESSORS: Janet Aikins; Mary Morris Clark; Lester A. Fisher; Melody Graulich; Rochelle Lieber; McKeel McBride; Thomas R. Newkirk; Patrocinio Schweickart; David V. Siddall; David H. Watters; Ronald A. Winslow, Jr.

GRADUATE PROGRAM COORDINATOR:  
Michael V. DePorte

The Department of English offers three advanced degrees, Master of Arts, Master of Science for Teachers, and Doctor of Philosophy. All applicants are required to submit Graduate Record Examination scores for the aptitude test. Applicants for the Master of Arts in Literature, the Master of Science for Teachers, and the Doctor of Philosophy degree programs must submit scores for the Advanced Test of Literature in English. All applicants must submit writing samples. Applicants for the Ph.D. are normally expected to have a reading knowledge of at least one foreign language. Specific requirements for each degree program can be obtained from the department.

### ***Master of Arts Programs***

#### ***Master of Arts in Literature***

The Master of Arts may be undertaken as a terminal degree or as preparation for a doctoral program. The program encourages students to pursue their individual interests and to correct deficiencies in their undergraduate training.

An M.A. candidate must pass eight 4-credit courses. Seven courses, including at least two seminars and either Engl 895 or 896, must be at the 800 level. At least four courses must be in English or American literature (as distinct from courses in critical analysis, linguistics, writing, teaching methods, or other literatures). Each M.A. candidate must pass at least one course in the English language or in the teaching of composition. As a general rule, all courses counting toward the M.A. degree should be taken in the English department. In special circumstances, however, a student may be allowed to apply toward the degree up to two graduate courses offered by other departments. For students planning a teaching career, the department requires at least one semester of teaching experience (subject to availability of funds).

An M.A. candidate must pass a reading examination in a foreign language. Foreign students whose native language is not English may be exempt from this requirement. Each candidate for the M.A. degree must register for four credits of Engl 895 or 896 and produce a substantial scholarly paper.

#### ***Master of Arts in Writing***

The Master of Arts in Writing is designed for students who intend to become professional writers. Eight working writers supervise the program. Students may elect to specialize in fiction, nonfiction, or poetry. Each member of the writing faculty is accomplished in at least one of these fields.

The writers at UNH emphasize conference teaching. Each student meets frequently with writers specializing in the student's area of study. In addition, each student works closely with a writer-adviser throughout the program.

Workshop courses provide forums for prompt, detailed criticism of each student's writing by instructors and fellow students. Each student takes at least two workshops in his or her specialty and may elect to take an additional workshop in another area as well. Form-and-theory courses and literature courses complete the program. The program consists of eight courses, of which seven must be at the 800 level.

Upon completion of the required courses, the student submits a portfolio of writing to the staff. The portfolio might consist of short stories, a novel, nonfiction articles, nonfiction book, or a collection of poetry. The degree is awarded upon approval of the portfolio by a committee of writers. There is no foreign language requirement.

#### ***Master of Arts in English Language and Linguistics***

Students who wish to specialize in any of the various areas of English language and linguistics may design an M.A. program to meet their interests. Specialties include Applied Linguistics and the Teaching of English as a Second Language as well as the traditional subfields of linguistics. Psycholinguistics courses are offered through the psychology department.

To earn the M.A. degree, students must complete at least seven 4-credit courses, including two seminars, plus 4 credits of Engl 895 or 896, and produce a substantial scholarly paper. At least six of these courses must be at the 800 level. Unless the student already has a strong background in linguistic theory, the program of study must include one course in phonetics and phonology (Engl 893) and one in syntax and semantics (Engl 894). Reading knowledge of one foreign language is required. The student's course of study must be approved by the program adviser.

#### ***Master of Science for Teachers***

The Master of Science for Teachers is designed for high school teachers. No foreign language is required. The student must pass eight 4-credit courses in English, numbered 700 and above, normally including at least one course in the teaching of writing and in the study of language, which will not be a repetition of undergraduate work. Applicants should consult the General Regulations of the Graduate School for the special admissions requirements for this program.

#### ***Doctor of Philosophy***

A student admitted to the Ph.D. program must hold an M.A. degree or be in the final stage of completing requirements for the degree.

The Ph.D. program offers professional training in the teaching of literature and language. The program combines the essential guidance and discipline of coursework with the equally essential freedom of independent study and research. Accordingly, in the first year the student is encouraged to follow a program suited to individual interests and needs.

Ph.D. candidates will normally complete ten English courses beyond the M.A. degree. Four of

these courses must be graduate seminars in this department. The other courses should be at the 800 level and must include: Introduction to the Teaching of Writing (Engl 810); a course on criticism; a half-course (2-credit) ungraded module on the teaching of literature (Engl 839); and a half-course (2-credit) ungraded module on bibliography and professional methods (Engl 800). In special circumstances, a course at the 700 level or a course from another department may be included among the ten courses with approval of the graduate committee.

In addition to meeting course requirements, each student must pass: 1) reading examinations in two foreign languages; 2) after preliminary work for the Ph.D. degree, a general examination; and 3) a later qualifying examination in three areas related to a proposed dissertation and projected teaching specialties. A student must also write a dissertation and defend it at a final oral examination.

M.A. and Ph.D. students holding assistantships teach under supervision; such teaching is considered a vital part of the student's professional training. At least a year of intern teaching or its equivalent is required of all doctoral candidates.

Graduate students should note that not all seminars are offered every year. A detailed guide to the department's programs is available from the secretary for graduate programs, Department of English.

*See English department brochure for detailed descriptions of current course offerings.*

#### **701, 702/801, 802. ADVANCED WRITING OF FICTION**

Workshop discussion of advanced writing problems and readings of students' fiction. Individual conferences with instructor. Prereq: writing fiction or equivalent. Written permission of instructor required for registration. May be repeated for credit with the approval of the department chairperson. 4 cr.

#### **703, 704/803, 804. ADVANCED NONFICTION WRITING**

A workshop course for students intending to write publishable magazine articles or nonfiction books. Equal stress on research and writing techniques. Prereq: newswriting; written permission of instructor required. May be repeated for credit with the approval of the department chairperson. 4 cr.

#### **705, 706/805, 806. ADVANCED WRITING OF POETRY**

Workshop discussion of advanced writing problems and submitted poems. Individual conferences with instructor. Prereq: writing poetry or equivalent. Written permission of instructor required for registration. May be repeated for credit with the approval of the department chairperson. 4 cr.

#### **707/807. FORM AND THEORY OF FICTION**

A writer's view of the forms, techniques, and theories of fiction. The novels, short stories, and works of criticism studied will vary, depending on the instructor. 4 cr.

#### **708/808. FORM AND THEORY OF NONFICTION**

A writer's view of contemporary nonfiction, emphasizing the choices the writer faces in the process

of research and writing. 4 cr. (Not offered every year.)

#### **709/809. FORM AND THEORY OF POETRY**

A writer's view of the problems, traditions, and structures of poetry. 4 cr.

#### **710/810. TEACHING WRITING**

An introduction to various methods of teaching writing. Combines a review of theories, methods, and texts with direct observation of teaching practice. 2 or 4 cr. (Degree candidates must enroll for 4 cr.)

#### **712. CRITICAL ANALYSIS OF EXPOSITION**

For the English teaching major; students analyze essays and write nonfiction prose. Variety of critical approaches; several methods of teaching composition. 4 cr. (Not offered every year.)

#### **713, 714/813, 814. LITERARY CRITICISM**

Major critics from Plato to the present; the chief critical approaches to literature. 4 cr. (Not offered every year.)

#### **715/815. APPLIED LINGUISTICS**

Methods of teaching and learning foreign languages; background work on theories of language acquisition; the methodology of teaching English as a second language. Students interested in teaching other languages may do their projects on those languages. 4 cr.

#### **716/816. PROBLEMS IN APPLIED LINGUISTICS**

Variable topics course; problems such as language acquisition in children and adults, bilingualism, and linguistic field methods. 4 cr. (Not offered every year.)

#### **718/818. ENGLISH LINGUISTICS**

Introduction to the study of language; dialects and social and psychological problems of language; intensive work on the techniques of modern grammar (syntax, phonology, semantics). 4 cr. (Not offered every year.)

#### **719. ENGLISH GRAMMAR**

Traditional and contemporary approaches to the study of the structure of the English language: its history, phonology, morphology, syntax including consideration of parts of speech, phrases, clauses, sentences, etymology, punctuation. Some emphasis on the teaching of English grammar. 4 cr.

#### **720. NEWSPAPER INTERNSHIP**

Students intending to pursue careers in journalism spend a semester working full- or part-time for a daily newspaper under close supervision of editors. Reporting is stressed, but students may do some editing as well. The number of internships is very limited. Prereq: newswriting or equivalent; and permission. 4-16 cr.

#### **741/841. LITERATURE OF EARLY AMERICA**

Prose and poetry of the periods of exploration, colonization, early nationalism, Puritanism, Enlightenment. Individual works and historical-cultural background. 4 cr. (Not offered every year.)

**742/842. AMERICAN LITERATURE, 1815-1865**

Fiction, nonfiction, and poetry in the period of romanticism, transcendentalism, nationalism. Individual works and cultural background. 4 cr. (Not offered every year.)

**743/843. AMERICAN LITERATURE, 1865-1915**

Fiction, nonfiction, and poetry in the period of realism, naturalism, industrialism, big money. Individual works and cultural background. 4 cr.

**744/844. AMERICAN LITERATURE, 1915-1945**

Fiction, poetry, and drama in the period of avant-garde and leftism, jazz age, and depression. Individual works and cultural background. 4 cr.

**745/845. CONTEMPORARY AMERICAN LITERATURE**

A gathering of forms, figures, and movements since 1945. Individual works and cultural background. 4 cr.

**746/846. STUDIES IN AMERICAN DRAMA**

Topics vary from year to year. Examples: 20th-century American drama; contemporary playwrights; theatricality in American life. 4 cr. (Not offered every year.)

**747/847. STUDIES IN AMERICAN POETRY**

Topics vary from year to year. Examples: poets of the open road; Pound and his followers; major American poets; contemporary American poetry. 4 cr. (Not offered every year.)

**748/848. STUDIES IN AMERICAN FICTION**

Topics vary from year to year. Examples: the romance in America; the short story; realism and naturalism; the city novel; fiction of the thirties. 4 cr.

**749/849. MAJOR AMERICAN AUTHORS**

Intensive study of two or three writers. Examples: Melville and Faulkner; Fuller, Emerson, and Thoreau; James and Wharton; Dickinson and Frost. 4 cr.

**750/850. SPECIAL STUDIES IN AMERICAN LITERATURE**

Topics vary from year to year. Examples: the Puritan heritage; ethnic literatures in America; landscape in American literature; five American lives; pragmatism; American humor; transcendentalism; women regionalists. 4 cr.

**751/851. MEDIEVAL EPIC AND ROMANCE**

The two major types of medieval narrative; comparative study of works from England, France, Germany, and Iceland, including *Beowulf*, *Song of Roland*, *Niebelungenlied*, Gottfried's *Tristan*, *Njal's Saga*, and Malory's *Morte d'Arthur*. All works read in modern English translations. 4 cr. (Not offered every year.)

**752/852. HISTORY OF THE ENGLISH LANGUAGE**

Evolution of English from the Anglo-Saxon period to the present day. Relations between linguistic change and literary style. 4 cr. (Not offered every year.)

**753/853. OLD ENGLISH**

Introduction to Old English language and literature through the readings of selected poetry and prose. 4 cr.

**754/854. BEOWULF**

A reading of the poem and an introduction to the scholarship. Prereq: Engl 753. 4 cr.

**755, 756/855, 856. CHAUCER**

755/855: *Troilus and Criseyde*, in the context of medieval continental literature by Boccaccio and other influences. 756/856: Chaucer—A study of *The Canterbury Tales* in its original language. 4 cr.

**758/858. SHAKESPEARE**

A few plays studied intensively. Live and filmed performances included as available. 4 cr.

**759/859. MILTON**

Milton and his age. Generous selection of Milton's prose and poetry, with secondary readings of his sources and the scholarship. 4 cr. (Not offered every year.)

**763/863. CONTINENTAL BACKGROUNDS OF THE ENGLISH RENAISSANCE**

Major philosophers, artists, and writers of the continental Renaissance (in translation): Petrarch, Ficino, Pico, Vives, Valla, Castiglione, Machiavelli, Luther, Calvin, Rabelais, Montaigne, Cervantes, Erasmus, and Thomas More, as representative of the early English Renaissance. 4 cr. (Not offered every year.)

**764/864. PROSE AND POETRY OF THE ELIZABETHANS**

Shakespeare and his contemporaries. Major works, including Spenser's *Faerie Queene*, Sidney's *Astrophel and Stella*, Shakespeare's *Sonnets*, Marlow's *Dr. Faustus*: their literary and intellectual backgrounds. 4 cr. (Not offered every year.)

**765/865. ENGLISH LITERATURE IN THE 17TH CENTURY**

Major writers of the 17th century, including Donne, Jonson, Herbert, Bacon, and Hobbes. 4 cr. (Not offered every year.)

**767, 768/867, 868. LITERATURE OF THE RESTORATION AND 18TH CENTURY**

Representative works; texts studied closely; the ways they reflect the central intellectual problems of their age. 767: Dryden, Rochester, Restoration plays, Bunyan, Defoe, Montesquieu, and Swift. 768: Pope, Fielding, Johnson, Boswell, Voltaire, Sterne, Rousseau, Beckford, Diderot, and Blake. 4 cr.

**769, 770/869, 870. THE ENGLISH ROMANTIC PERIOD**

Major literary trends and authors, 1798 to 1832. Focus on poetry but attention also to prose works and critical theories. 769: Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey. 770: Byron, Shelley, Keats. 4 cr. (Not offered every year.)

**771, 772/871, 872. VICTORIAN PROSE AND POETRY**

Major writers; social and cultural history. Typically included in 771, Carlyle, Ruskin, Newman, Tennyson, Browning, and others; in 772, Arnold, the pre-Raphaelites, Swinburne, Hopkins, and others. 4 cr. (Not offered every year.)

**773, 774/873, 874. BRITISH LITERATURE OF THE 20TH CENTURY**

Poets and novelists; the concept of modernity in literature. Offerings vary by year and by instructor, but normally include such figures as Joyce, Lawrence, Yeats, Woolf, Forster, and more contemporary writers such as Burgess, Fowles, Murdoch, and Golding. 4 cr.

**775/875. IRISH LITERATURE**

Survey from the beginnings to the present; works in Irish (read in translation) such as *The Cattle Raid of Cooley*, medieval lyrics, and *Mad Sweeney*; and works in English from Swift to the present. Twentieth-century authors: Joyce, Yeats, Synge, O'Casey, Beckett, and Flann O'Brien. 4 cr. (Not offered every year.)

**778/878. BRAIN AND LANGUAGE**

An introduction to neurolinguistics, a study of how language is related to the structure of the brain. The biological foundations of linguistic universals and language acquisition. Examination of evidence from aphasia and from normal language use. 4 cr.

**779/879. LINGUISTIC FIELD METHODS**

Devoted to the study, with use of an informant, of some non-Indo-European language that is unfamiliar to both the students and the instructor at the beginning of the class. The primary aim of the course is to give students a practical introduction to linguistic analysis without the support of a text. Theoretical concepts will be introduced as needed. 4 cr.

**780/880. ENGLISH DRAMA TO 1640**

Development of the drama through the Renaissance, emphasizing the Elizabethan and Jacobean dramatists. 4 cr.

**781/881. ENGLISH DRAMA FROM 1660 TO 1780**

Representative plays, both serious and comic, by such writers as Wycherley, Congreve, Etherege, Goldsmith, Sheridan, Davenant, Dryden, Otway, Rowe, and Lillo. 4 cr.

**782/882. MODERN DRAMA**

Major English, American, and (translated) European plays of the modern period by such playwrights as Shaw, Ibsen, Chekhov, Strindberg, Pirandello, O'Neill, Brecht, Beckett, Williams, Miller, Pinter. Live and filmed performances studied as available. 4 cr. (Not offered every year.)

**783/883. THE ENGLISH NOVEL OF THE 18TH CENTURY**

The rise and development of the novel through study of selected major works by Defoe, Richardson, Fielding, Smollett, Sterne, and Austen. 4 cr.

**784/884. THE ENGLISH NOVEL OF THE 19TH CENTURY**

Representative novels from among Austen, Scott, Dickens, Thackeray, Emily Brontë, Charlotte

Brontë, Trollope, George Eliot, Hardy, and Conrad. 4 cr.

**785/885. MAJOR WOMEN WRITERS**

Intensive study of one or more women writers. Selections vary from year to year. 4 cr.

**790/890. SPECIAL TOPICS IN LINGUISTIC THEORY**

An advanced course on a topic to be chosen by the instructor. Inquire at the English department office for a full course description each time the course is offered. Topics such as dialectology, Montague grammar, African linguistics, linguistics and literature, metrics, cross-disciplinary studies relating to linguistics. Barring duplication of subject, may be repeated for credit. 4 cr.

**792. TEACHING SECONDARY SCHOOL ENGLISH**

Methods of teaching language, composition, and literature in grades 7-12. Required of all students in the English teaching major. Open to others with permission. 4 cr.

**793/893. PHONETICS AND PHONOLOGY**

The sounds and sound systems of English in the context of linguistic theory: comparisons of English to other languages. Prereq: a basic linguistic course or permission. 4 cr. (Not offered every year.)

**794/894. SYNTAX AND SEMANTIC THEORY**

The relationship of grammar and meaning as viewed from the standpoint of modern linguistic theory. Emphasis on the syntax and semantics of English, with special attention to the construction of arguments for or against particular analyses. Prereq: a basic linguistic course or permission. 4 cr.

**795, 796. INDEPENDENT STUDY**

To be elected only with permission of the department chairperson and of the supervising faculty member or members. Barring duplication of subject, may be repeated for credit up to a maximum of 16 credits. I-16 cr.

**797, 798/897, 898. SPECIAL STUDIES IN LITERATURE**

A) Old English Literature; B) Medieval Literature; C) 16th Century; D) 17th Century; E) 18th Century; F) English Romantic Period; G) Victorian Period; H) 20th Century; I) Drama; J) Novel; K) Poetry; L) Nonfiction; M) American Literature; N) A Literary Problem; O) Literature of the Renaissance. The precise topics and methods of each section will vary. Barring duplication of subject, may be repeated for credit. For details, see the course descriptions available in the English department. 4 cr.

**800. BIBLIOGRAPHY AND METHODS**

Introduction to enumerative and physical bibliography and major research and reference works of the field, to prepare the student for original research in the graduate program and later. Required of all Ph.D. students. 2 cr. Cr/F.

**817. SEMINAR IN TEACHING WRITING**

Review of the current professional literature on composition; research projects in areas selected in

consultation with instructor. Prereq: Engl 810 or permission. 4 cr.

**820. SEMINAR IN LINGUISTICS**  
4 cr.

**821. SEMINAR—STUDIES IN OLD ENGLISH**  
4 cr.

**824. SEMINAR—STUDIES IN MEDIEVAL LITERATURE**  
4 cr.

**825. SEMINAR—STUDIES IN 16TH-CENTURY LITERATURE**  
4 cr.

**827. SEMINAR—STUDIES IN SHAKESPEARE**  
4 cr.

**828. SEMINAR—STUDIES IN MIGRATION**  
4 cr.

**829. SEMINAR—STUDIES IN EARLY 17TH-CENTURY LITERATURE**  
4 cr.

**830. SEMINAR—STUDIES IN 18TH-CENTURY LITERATURE**  
4 cr.

**832. SEMINAR—STUDIES IN THE ROMANTIC PERIOD**  
4 cr.

**833. SEMINAR—STUDIES IN THE VICTORIAN PERIOD**  
4 cr.

**834. SEMINAR—STUDIES IN 20TH-CENTURY BRITISH LITERATURE**  
4 cr.

**837. SEMINAR—STUDIES IN 19TH-CENTURY AMERICAN LITERATURE**  
4 cr.

**838. SEMINAR—STUDIES IN 20TH-CENTURY AMERICAN LITERATURE**  
4 cr.

**839. PROBLEMS IN TEACHING ENGLISH**

Special topics in teaching within the discipline of English. Inquire at the department to see what topics in the teaching of literature, language, or writing may be scheduled. Open only to graduate students with a professional interest in teaching or to practicing teachers. 1-6 credits depending on the specific course.

**840. SEMINAR—STUDIES IN ENGLISH DRAMA**  
4 cr.

**895, 896. READING AND RESEARCH**  
2, 4, or 8 cr. IA, Cr/F.

**899. MASTER'S THESIS**  
6 cr.

**999. DOCTORAL RESEARCH**

**Entomology (Ento)**

**Chairperson:** G. Thomas Fisher

**ASSOCIATE PROFESSORS:** James S.

Bowman; G. Thomas Fisher; R. Marcel Reeves

**ASSISTANT PROFESSORS:** John F. Burger;

Donald S. Chandler; Paul C. Johnson

**ADJUNCT ASSISTANT PROFESSOR:**

Siegfried E. Thewke

An applicant for admission to graduate study in entomology is expected to have at least the basic (Ento 402) course in entomology as well as adequate preparation in the allied sciences of chemistry, botany, and zoology. During the first semester of residency, degree candidates' backgrounds in entomology will be reviewed in conference with at least three faculty members. Students lacking the necessary background courses may be required to complete certain of these courses, which do not carry credit, before they are admitted to full candidacy for a degree.

The program of graduate study is designed to meet the needs of those students planning to take further work leading to a career in professional entomology. Areas of specialization include taxonomy, ecology, ethology, biological control, pest management, chemical control, problems in medical entomology, forest entomology, and agricultural entomology. A thesis is required of all candidates for the master's degree. An oral examination on the thesis is required. Students are given the opportunity to assist the professional staff in field research and as laboratory assistants, and they are also encouraged to attend professional meetings in their appropriate fields.

No language requirements are made for the M.S. degree. Applicants are required to submit aptitude and advanced biology scores from the Graduate Record Examination.

**704. MEDICAL ENTOMOLOGY**

Survey of past and present trends in arthropod-borne diseases transmitted to human populations, emphasizing dynamics of arthropod-host-pathogen/parasite relationships, natural nidality of disease, and role of arthropods and other animals as reservoirs or vectors of disease and maintenance of zoonoses. Laboratory emphasizes survey of arthropod groups important as disease vectors or in envenomizing humans. Mr. Burger. Lab. 4 cr.

**705. SYSTEMATICS AND TAXONOMY OF INSECTS**

The kinds and diversity of insects and their relationships, emphasizing methods of species and population analysis, concepts of classification and nomenclature, and application to identification. Prereq: intro entomology; /or permission. Mr. Burger, Mr. Chandler. Lab. 4 cr.

**706. SOIL ARTHROPODS**

Biology and systematics of terrestrial arthropods, with emphasis on the springtails, sowbugs, myriapods, mites, spiders, and other arachnids. Prereq: permission. Mr. Reeves. Lab. 4 cr. (Not offered every year.)

**707. IMMATURE INSECTS**

Identification of immature stages of insects, especially of holometabolous orders. Aquatic forms not

included. Prereq: insect morphology, intro ento, or permission. Mr. Thewke. 4 cr. (Not offered every year.)

### **709. AQUATIC INSECTS**

Biology, ecology, and taxonomy of aquatic insects, including their role in succession and food webs of aquatic ecosystems, origin and evolution of adaptations to aquatic environments and relationship between habitat type and faunal diversity. Laboratory emphasizes qualitative and semi-quantitative sampling techniques, collection and identification of principal aquatic groups. Prereq: intro ento, principles of zoology, or permission. Mr. Burger. Lab. 4 cr. (Not offered every year.)

### **710. INSECT MORPHOLOGY**

External and internal anatomy of insects, with the integration of body structure and function. Prereq: permission. Mr. Chandler. Lab. 4 cr. (Not offered every year.)

### **720. AGRICULTURAL ENTOMOLOGY**

For advanced students interested in agribusiness. Economic effect of insect pests on forage, fruit, and vegetable crops. Life cycles; damage and current methods of control. Prereq: permission. Mr. Fisher. Lab. 4 cr.

### **721. PRINCIPLES OF BIOLOGICAL CONTROL**

Natural and applied aspects of biological control of insect and plant pests. Prereq: permission. Mr. Reeves. 4 cr. (Not offered every year.)

### **722. CHEMICAL CONTROL OF INSECTS**

For advanced students in applied entomology. Review of the chemical compounds for insect control. Modes of pesticide entry; toxicology. Basic understanding of chemistry is desired. Prereq: permission. Mr. Fisher. Lab. 4 cr.

### **723. REGULATORY PEST CONTROL**

For students preparing for careers dealing directly with or associated with the movement of agricultural commodities in internal and foreign trade. Legal documents; federal and state statutes. Prereq: basic entomology and plant pathology courses; permission. Mr. Thewke. 2 or 4 cr. (Not offered every year.)

### **724. STRUCTURAL PEST CONTROL**

For students wishing to study household and industrial entomology. Prereq: permission. Mr. Fisher. Lab. 4 cr.

### **801, 802. GRADUATE ENTOMOLOGY**

Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Mr. Reeves, Mr. Burger, and Mr. Bowman. Subject matter, hours, and credits to be arranged.

### **825. INSECT ECOLOGY**

Role of insects in: coevolution of plant-herbivores and predator/parasite-prey systems, ecosystem energetics, population dynamics, niche theory, competition, coexistence, diversity, and stability. Prereq: permission. Mr. Johnson. 4 cr. (Not offered every year.)

### **826. INTEGRATED PEST MANAGEMENT**

Integration of pest management techniques involving biological, culture, and chemical control with principles of insect ecology into management approach for insect pests. Prereq: permission. Mr. Johnson. 4 cr. (Not offered every year.)

### **897, 898. ENTOMOLOGY SEMINAR**

Selected topics and current developments. Required of all graduate entomology students. May be repeated. Staff. 1 cr.

### **899. MASTER'S THESIS**

Mr. Burger, Mr. Fisher, Mr. Reeves, Mr. Johnson, Mr. Chandler and staff. Hours and credits to be arranged. 6-10 cr.

## **Genetics Program (Gen)**

**Chairperson:** Yun-Tzu Kiang

**PROFESSORS:** James P. Barrett; Walter M. Collins; Thomas P. Fairchild; Donald M. Green; Harold W. Hocker, Jr.; Frank K. Hoornbeek; J. Brent Loy; Lincoln C. Peirce; Owen M. Rogers

**ASSOCIATE PROFESSORS:** Yun-Tzu Kiang; Subhash C. Minocha; Willard E. Urban, Jr.; Robert M. Zsigray

**ASSISTANT PROFESSORS:** Robert T. Eckert; Florence E. Farber

**ADJUNCT ASSISTANT PROFESSORS:** Maurice E. Demeritt, Jr.; Peter W. Garrett

The interdepartmental Genetics Program offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

Qualified students are admitted to the program with the approval of the genetics faculty and the chairperson of the department in which they have a major interest. Undergraduate preparation should include mathematics through calculus, chemistry through organic, physics, animal or plant biology courses and laboratories, and genetics with laboratory. Preparation in statistics and computer science is desirable. All students will be examined shortly after they arrive in order to diagnose their preparation in basic genetics. Students lacking the appropriate preparation may be admitted but will be required to complete certain courses without graduate credit. The aptitude section of the Graduate Record Examination is required.

The program is conducted by faculty members from animal sciences, biochemistry, botany, the Institute of Natural and Environmental Resources, microbiology, plant science, and zoology, as well as faculty from the Agricultural Experiment Station and the U.S. Forest Service, Northeastern Forest Experiment Station.

The core curriculum in genetics requires students in the Ph.D. program to take a minimum of one course from each of the following groups of courses: 1) Population Genetics—Introductory course, Gen 705; 2) Molecular Genetics—Biochemical Genetics, Gen 770; Microbial Genetics, Micr 804; Regulation of Gene Expression, PlSc 803k; 3) Classical Genetics—Plant Genetics, PlSc 851; Cytogenetics, PlSc 853; Quantitative Genetics and Selection, AnSc 812; Human Genetics, Zool 707. All students are required to participate in a one-year directed teaching experience and are required to attend genetics seminars.

The requirements for the M.S. candidates will be a minimum of one course from each of any two of the above three groups of courses.

**Master of Science Degree**

The program for the Master of Science degree is formulated by the student with the approval of the guidance committee. Candidates for the degree will be required to complete a thesis, pass an oral examination covering graduate courses and thesis, and complete courses designated in the core curriculum.

**Doctor of Philosophy Degree**

The chairperson of the Genetics Program, with the concurrence of the chairperson of the department of major interest, will nominate the student's guidance and doctoral committees, which will administer the qualifying and final examinations. Specific course requirements will be developed by the student and the guidance committee, and will include the courses in the core curriculum. Students must complete a dissertation on original research in genetics.

The guidance committee for each graduate student will determine whether a foreign language will be required.

**705. POPULATION GENETICS**

Population growth and regulation; genetic variation; factors affecting gene frequency; ecological genetics. Prereq: prin of genetics or permission. 4 cr. (Offered fall 1982.)

**706. GENETICS LABORATORY**

Experiments and demonstrations in animal, plant, and microbial genetics and cytogenetics, including research techniques applicable to biochemical, population, and transmission genetics. Prereq: prin of genetics or equivalent. Staff. 3 cr.

**740. EVOLUTIONARY BIOLOGY**

Origin of source of genetic variation, population structure, mechanisms of evolution; molecular evolution; ecological adaptation in animals, plants, and man; community structure and evolution. Prereq: prin of genetics or permission. 4 cr. (Not offered every year.)

**770. BIOCHEMICAL GENETICS**

Mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: Bchm 751 or permission. Mr. Green. 4 cr. (Not offered every year.)

**802. DESIGN OF EXPERIMENTS**

The philosophy of experimental design and how it relates to standard statistical designs. Topics include the roles of replication and randomizations, factorially arranged treatments, Latin squares, incomplete nonfactorial designs, fractional replications and confounding, and crossover designs. Mr. Warren. Prereq: INER 711; digital computer systems; /or permission. 4 cr. (Not offered every year.)

**812. ADVANCED STATISTICAL METHODS**

Methods and techniques for handling typical problems that arise in the analysis of data. Topics include the multiple comparison of means, analysis of unweighted means, proportional subclass numbers, weighted squares of means, orthogonal polynomials, and least squares. Mr. Urban. Prereq: FoRs 711; digital computer systems; /or permission. 3 cr. (Not offered every year.)

**895, 896. SPECIAL TOPICS IN GENETICS**

Intended for study in specialty areas not ordinarily included in other courses. May involve formal classes, discussions, or independent investigations. Prereq: permission of staff concerned. 2-4 cr.

**898. GENETICS SEMINAR**

Presentation and discussion of selected genetic topics. Staff. 1 cr. (May be repeated.)

**899. MASTER'S THESIS**

6-10 cr.

**999. DOCTORAL RESEARCH**

**Courses Available in Related Areas**

These courses are fully described below and under the course of the appropriate department for the convenience of the student.

**Animal Sciences**

**711. COMPARATIVE ANIMAL GENETICS**

How heredity affects domestic animals, poultry, other mammals, and fish; emphasis on the organism and population. Quantitative inheritance; principles of selection; disease resistance; statistical and experimental techniques. Prereq: 4 cr. of genetics; /or permission. Mr. Collins. Lab. 4 cr.

**712. ANIMAL BREEDING AND IMPROVEMENT**

Principles of selection and breeding systems as they apply to the genetic improvement of dairy cattle, livestock, and horses. Prereq: AnSc 711 or permission. Mr. Cady. Lab. 4 cr. (Not offered every year.)

**812. QUANTITATIVE GENETICS AND SELECTION**

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Mr. Collins. Prereq: one course each in genetics and statistics. 3 cr. (Not offered every year.)

**Institute of Natural and Environmental Resources**

**711. STATISTICAL METHODS II**

Intermediate course; basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangement of treatments, multiple regression, and covariance. Computer programs used in analyzing data. Examples from environmental sciences. Prereq: ap-

plied statistics I or equivalent. Mr. Barrett, Mr. Warren. 4 cr.

### **Forest Resources**

#### **720. FOREST GENETICS**

Genetics of forest tree improvement; variation in natural populations, breeding methods, physiological characters, quantitative data analysis. Prereq: principles of genetics; silviculture; /or permission. Transportation fee. Mr. Eckert. Lab. 3 cr. (Not offered every year.)

### **Microbiology**

#### **804. MICROBIAL GENETICS**

Expression, regulation, recombination, and transmission of genetic information in prokaryotic and eukaryotic microorganisms. Consideration of chromosomal inheritance. Prereq: gen micr; permission. Lab. 4 cr. (Not offered every year.)

### **Plant Science**

#### **773. METHODS AND THEORY OF PLANT BREEDING**

Plant breeding systems for qualitative and quantitative plant improvement. Prereq: introductory genetics; introductory statistics; /or permission. Mr. Peirce. 3 cr. (Not offered every year.)

#### **851. PLANT GENETICS**

Euploidy, aneuploidy, cytoplasmic inheritance, somatic cell genetics, and genetics of disease resistance in plants. Prereq: intro genetics. 3 cr. (Not offered every year.)

#### **853. CYTOGENETICS**

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cytogenetic analysis. Mr. Rogers. Prereq: genetics; cytology. 3 cr. (Not offered every year.)

### **Zoology**

#### **707. HUMAN GENETICS**

Inheritance patterns, gene and chromosome mutation rates and effects, linkage, and gene frequency. Prereq: prin of genetics or permission. 4 cr. (Not offered every year.)

## **History (Hist)**

**Chairperson:** Donald J. Wilcox

**PROFESSORS:** Charles E. Clark; Robert C. Gilmore; Hans Heilbronner; Charles A. Jellison, Jr.; William R. Jones; David F. Long; Francis D. McCann, Jr.; Robert M. Mennel; Darrett B. Rutman; Cecil J. Schneer; John O. Voll; Douglas L. Wheeler; Donald J. Wilcox

**ASSOCIATE PROFESSORS:** Jeffry M. Diefendorf; Marion E. James; Allen B. Linden; Marc L. Schwarz; Harvard Sitkoff

**ASSISTANT PROFESSOR:** Janet L. Polasky  
**GRADUATE PROGRAM COORDINATOR:** Robert M. Mennel

### **Admission**

The department usually requires completion on the undergraduate level of eight semester courses in history together with some preparation in other areas of the humanities and social sciences.

Applicants for admission to any graduate program in history should have a minimum of B+ average in history and allied humanities and social sciences. In addition, applicants must submit Aptitude (verbal and quantitative) and Advanced History scores on the Graduate Record Examinations. The department assesses the student's entire application, including letters of recommendation, in making its decision on admission. Deficiencies in an undergraduate program may be rectified by course work as a special student, but such coursework cannot be used to satisfy requirements for an advanced degree. The department also recommends that a beginning graduate student have some training in a foreign language. It should be noted that students who expect to participate in seminar or reading courses in other than American history are usually required to have a reading knowledge of at least one foreign language appropriate to the particular course. Applicants intending the Ph.D. degree should include with their applications a personal statement indicating their reason for and intentions in undertaking graduate study at the University of New Hampshire.

All graduate students are reviewed annually by the faculty of the department. A student accumulating two course failures is automatically barred from continuing in any degree program in history, but the department reserves the right to exclude others whose overall performance does not give reasonable assurance of a successful program completion. Students are allowed no more than three attempts to meet any language requirements.

### **Degree Programs**

The department offers the Master of Arts and Doctor of Philosophy degrees. The general degree requirements are outlined below, but specific programs are tailored to the goals of the student. The graduate program coordinator of the department serves as the initial adviser to entering graduate students, the adviser-of-record to all students throughout their years of graduate study, and, with the Graduate Committee of the department, has general supervision of all student programs. By the beginning of a student's second semester in residence, the student intending a degree will ordinarily have selected a single member of the faculty as the program chairperson and, with that faculty member as principal adviser, will have worked out a specific program of studies leading toward a degree.

The graduate program coordinator must approve the registration of special students and students from other departments in graduate history courses. The department welcomes the opportunity to work with students from other departments.

#### **Master of Arts**

The student intending the M.A. degree has the choice of designing a specific program to meet either of two sets of requirements; the first allows substantial training and research in a single subfield of history but within a foundation of broader

coursework; the second allows substantial breadth over at least two subfields. The subfields in history are as follows: the Ancient World; Medieval Europe; Early Modern Europe; Modern Europe; European Intellectual History; Medieval England; Early Modern England; Modern England; Iberian History; Russia; Early American History; Modern American History; Colonial Latin America; Modern Latin America; the Far East; the Near East; Sub-Saharan Africa; and the History of Science.

Completion of the degree under either set of requirements normally requires between three and four semesters of full-time study (three to four courses per semester). Either plan may prepare a student for entrance to the Ph.D. program. Plan B is particularly recommended for practicing teachers.

**Plan A:** The student shall complete successfully at least eight courses in history numbered above 700, of which a minimum of four shall be numbered between 800 and 898 (seminar and directed readings). In addition, the student shall prepare within the context of any single subfield a thesis meriting the unanimous approval of a thesis committee consisting of the student's program chairperson, under whose direction the thesis shall be prepared, and two other members of the graduate faculty (at least one of them in history). The preparation of the thesis is considered to be the equivalent of two additional semester courses each bearing the designation History 899 for the purpose of meeting the general regulations of the Graduate School.

**Plan B:** The student shall complete successfully at least ten courses in history numbered above 700 of which a minimum of four shall be numbered between 800 and 898. Following completion of coursework or during the final semester of coursework, the student shall demonstrate a broad competence in two subfields of history ordinarily in oral examination before a committee of three consisting of the student's program chairperson and two other members of the faculty in history. Students proceeding under Plan B shall have stood examination no less than three weeks prior to the Commencement at which the degree is to be granted.

Students should note that Plan A thesis readings and Plan B examinations during the summer are available only with the consent of all faculty involved.

### ***Doctor of Philosophy***

The department offers work leading toward the degree of Doctor of Philosophy with a concentration in either of the two subfields of American history. The degree requires more than formal coursework; it is awarded in recognition of high attainment and ability in history as shown by performance in qualifying examinations and by preparation and defense of a dissertation. Normally an entering student intending to be a candidate for the doctorate will complete an M.A. program as a prerequisite. Students with the M.A. from another institution, however, can begin the doctoral program immediately, and a student in residence can, with the consent of the department, omit the M.A. and proceed directly toward the Ph.D.

The doctoral student's cardinal intellectual relationship is with that member of the faculty under whom he or she will write the dissertation and

who serves as the student's program chairperson. This relationship should be established early and a broad program supportive of the intended area of dissertation research worked out in consultation with the program chairperson. The program, which must be approved by the Graduate Committee of the department, shall involve each of the following:

- 1) Two required research seminars in American history, one in early America and one in modern America.

The history department offers these required research seminars in the first semester of each year, alternating between the two fields. Each entering student, with or without the M.A., should take one in each of the first two years in the program. Other seminars and reading courses at the 800 level will also form part of the program drawn up in consultation with the student's program chairperson.

- 2) Required courses in historiography and historical methods. The history department will offer one of these courses in the second semester of each year, alternating between the historiography course and the historical methods course. Each entering student, with or without the M.A., should take one in each of the first two years in the program.

Note: No student will be considered to be intending to pursue a Ph.D. program who is not in the process of satisfying these requirements. Only students who are intending to pursue the Ph.D. are considered for graduate assistantships.

- 3) Two languages or one language and a special research technique, whichever is deemed most relevant to the area of research.

- 4) The entirety of American history, with accent upon either of the subfields of early or modern America, and two subfields outside of American history.

- 5) A cognate field outside of history entirely or a subfield of non-Western history.

Students' preparations for the qualifying examination will be guided by representatives of each subfield or cognate field in their programs. These representatives will make up a student's guidance and, subsequently, examining and dissertation committees. Students will normally not take the qualifying examination until they have completed sixteen semester courses or more (including work undertaken in a master's program). This requires three years of study beyond the bachelor's degree, the greater portion of which is ordinarily accomplished in full residence. Students should bear in mind, however, that qualifying examinations will test a mastery of broad subfields of historical knowledge rather than of particular courses. Students are, therefore, expected to read widely and independently in order to expand their knowledge beyond formal coursework and to become acquainted with aspects of the subfields not covered in that coursework.

Normally there will be eight steps in attaining the degree. Students are expected to be registered in the University for all regular academic semesters during their progress.

- 1) Satisfaction of historiography, historical methods, and research seminar requirements.

- 2) Correction of any deficiencies in the student's previous program, for example, lack of a first language.

- 3) The demonstration of proficiency in a second language or a special research technique. (Departmental regulations regarding the latter are available from the director of graduate studies.)

4) Successful performance in a two-part qualifying examination: the first part, a four-hour written examination covering breadth of knowledge in the subfield of specialization (early or modern American history); the second part, oral and covering all subfields and (if any) the cognate field specified in the program.

5) Within the same semester as step three, admission to candidacy and the approval by the candidate's dissertation committee of the specified topic and research plan for the dissertation.

6) Submission of an acceptable dissertation no more than three years after the admission to candidacy.

7) Successful public defense of the dissertation before the dissertation committee.

8) Formal submission of the dissertation to the department and Graduate School at least two weeks prior to the commencement at which the degree is to be conferred.

### **Apprenticeship**

The department considers that graduate work in history, and particularly doctoral work, is professional training. All entering graduate students intending a Ph.D. are, consequently, required (and all others are urged) to participate on a continuing basis in History 801, Proseminar: History as a Profession. Moreover, the department recognizes the dual concerns of the historian's life—teaching and research; when feasible, therefore, all doctoral students are expected to undertake teaching in the department during a part of their residence. Participation in pro-seminar and in teaching constitutes an apprenticeship in conjunction with formal study.

### **700. ADVANCED EXPLORATIONS IN HISTORY**

See department listings for semester topic. Barring duplication of subject, may be repeated for credit. 1-4 cr.

### **705, 706. AMERICA IN THE 18TH CENTURY AND THE REVOLUTION**

American colonial and revolutionary history from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. 4 cr.

### **711, 712. 19TH-CENTURY AMERICA**

Domestic and international factors in the development of the American republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. 4 cr.

### **715, 716. 20TH-CENTURY AMERICA**

U.S. after 1900; cultural, political, and social factors causing major changes in American life. Semester I: progressivism through the New Deal. Semester II: World War II to the present. 4 cr.

### **719, 720. THE FOREIGN RELATIONS OF THE UNITED STATES**

Primarily the history of American diplomacy, with attention given to the nondiplomatic aspects. Semester I: American Revolution to 1890. Semester II: 1890 to date. 4 cr.

### **721, 722. HISTORY OF AMERICAN THOUGHT**

Significant American thinkers considered in their social context. Semester I: 1600 to 1860. Semester II: 1860 to present. 4 cr. (Not offered every year.)

### **724. AMERICAN URBAN HISTORY**

Urbanization process from the colonial period to the present. 4 cr.

### **741. THE AGE OF THE RENAISSANCE**

The birth of the Renaissance, its economic, social, and political roots, and the flowering of Renaissance culture. Covers period from 1300 to 1600, with stress on Italy. 4 cr.

### **742. THE AGE OF REFORMATION**

The reformation of church, society, and human values that shook Europe in the 16th century, and its roots in the 14th and 15th centuries. 4 cr.

### **751, 752. EUROPEAN INTELLECTUAL HISTORY**

European intellectual tradition from the Greek philosophers to the end of World War II. How basic ideas have developed out of previous modes of thought in response to new challenges. 4 cr.

### **756. 20TH-CENTURY EUROPE**

World War I, European totalitarianisms, World War II, the loss of European primacy, and the search for a new Europe. 4 cr.

### **761, 762. ENGLAND IN THE TUDOR AND STUART PERIODS**

Political, religious, socio-economic, and intellectual forces for change at work in England from the accession of Henry VII to the revolution of 1688-89. 4 cr.

### **763. RUSSIA: ORIGINS TO MODERNIZATION**

Russia from its foundation to emancipation and reform. Political developments, foreign relations, intellectual and ideological currents. 4 cr.

### **764. RUSSIA: FROM TSARIST TO SOVIET EMPIRE**

The cost of modernization; Leninist and Stalinist revolutions; Soviet consolidation. 4 cr.

### **774. HISTORIOGRAPHY**

Analysis of ancient and modern historians. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)

### **775. HISTORICAL METHODS**

Introduction to contemporary historical methods. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)

### **777. THE HELLENISTIC-ROMAN WORLD**

The Mediterranean and Near East from the time of Alexander to the reign of Constantine. Covers the main political and social developments, but stresses artistic, scientific, philosophical, and religious trends, with particular emphasis on the rise of Christianity, Zoroastrianism, and the general

religious climate that prepared the way for Islam. 4 cr.

**789. SEMINAR IN THE HISTORY OF SCIENCE**

Selected topics conducted through special lectures, individual study, oral and written reports. Subject varies. Cannot be used for credit in history without permission of the department. Prereq: permission of adviser and instructor. 4 cr.

**790. QUANTIFICATION AND COMPUTERS FOR THE HISTORIAN**

The historian's use of computers and statistics; practical applications of both interactive terminal operations and batch processing. Data generation and processing, computer languages (BASIC, FORTRAN), programming and library programs, elementary statistics; students will undertake operations of their own on material supplied and will consider particular quantitative studies in history in terms of techniques used. No previous knowledge of computers or college mathematics required. Prereq: admission as an undergraduate major or graduate student in history or permission. 4 cr.

**791. RELIGION IN WORLD HISTORY**

The religious experience of man from the perspective of world history. The major modes of religion; development of the major religious traditions and institutions. 4 cr.

**797. COLLOQUIA IN HISTORY**

Selected topics in American, European, and non-Western history. Students must select section in department office at the time of registration. 4 cr.

***Graduate Readings and Seminars***

**801. PROSEMINAR: HISTORY AS A PROFESSION**

Entering graduate students intending the doctorate and all advanced graduate students serving as research, program, or teaching assistants in the department meet periodically to discuss the obligations and mechanics of the historian's profession, including teaching, scholarship, university and college structures, and the role of the faculty therein. 0 cr.

**819, 820. SEMINAR IN EARLY AMERICAN HISTORY**

I) Mr. Clark (social and cultural); 2) Mr. Gilmore (Revolution); 3) Mr. Rutman (Anglo-American society). Prereq: permission. 3 cr.

**823, 824. SEMINAR IN AMERICAN NATIONAL HISTORY**

1) (Afro-American); 2) Mr. Sitkoff (20th century); 3) Mr. Jellison (19th century and biography); 4) Mr. Mennel (social); 5) Mr. Long (foreign relations). Prereq: permission. 3 cr.

**836. SEMINAR IN LATIN AMERICAN HISTORY**

Topics will vary and will include: conservatism and conformity in Latin America; the Portuguese Empire; Brazil and Africa; the Mexican Revolution; nationalism and neocolonial Latin America; Brazil; empire and republic; and slavery in the Americas: a comparison. Mr. McCann. 3 cr.

**843, 844. SEMINAR/READINGS IN EUROPEAN HISTORY**

I) Mr. Heilbronner (modern Russia); 2) Mr. Jones (Medieval); 3) Ms. Polasky (France and European social history); 4) Mr. Wheeler (Spain and Portugal); 5) Mr. Wilcox (Renaissance). 3 cr.

**859, 860. SEMINAR IN ENGLISH HISTORY**

I) Mr. Schwarz (Tudor-Stuart). Prereq: permission. 3 cr.

**888. PROBLEMS IN MODERN AFRICAN HISTORY**

Topics will vary each year the seminar is offered. Emphasis will be on Africa south of the Sahara in the colonial and postcolonial eras. Among the topics will be: African resistance movements in pre-colonial and colonial Africa; African nationalism; problems of the independent African states; the role of the military in postcolonial Africa; and issues in Portuguese African history. Students will write research papers and give oral presentations. Mr. Wheeler. 3 cr.

**895, 896. TUTORIAL READING AND RESEARCH IN HISTORY**

A) Early American History; B) American National History; C) Canada; D) Latin America; E) Medieval History; F) Early Modern Europe; G) Modern European History; H) Ancient History; I) Far East and India; J) Near East and Africa; K) European Historiography; L) American Historiography; M) Russia; N) World History; O) English History; P) New Hampshire History; Q) Historical Methodology; R) Irish History. Prereq: permission. 1-6 cr.

**899. MASTER'S THESIS**

**999. DOCTORAL RESEARCH**

**Home Economics (HEc)**

**Chairperson:** Michael F. Kalinowski

**ASSOCIATE PROFESSORS:** Larry J. Hansen; Victor R. Messier; Elizabeth A. Snell; Henry J. Thompson

**ASSISTANT PROFESSORS:** Jennifer W. Bryce; Elizabeth M. Dolan; Colette H. Janson; Michael F. Kalinowski; Joel Rudd; Anthony R. Tagliaferro

The department offers graduate work leading to a Master of Science degree in home economics, with the major emphasis in areas which strengthen professional competence in child/family studies and consumer studies. Each student's program will be planned to achieve professional objectives based on specific interests, ability, and undergraduate preparation.

**Admission:** Students admitted to the graduate program in home economics are expected to have an undergraduate degree in home economics or a related field. If there are deficiencies in the undergraduate program, students may be admitted on condition that they complete specified prerequisites which will not be counted toward the degree. Students seeking admission must submit recent scores from the Graduate Record Examination.

**Requirements:** A candidate for a Master of Science in home economics is expected to fulfill the general requirements of the Graduate School and the following departmental requirements:

1) A minimum of 22 semester credits in home economics courses above the 800-level, including Research Seminar, and Thesis, HEc 899.

2) Soc801: Sociological Methods I, Intermediate Social Statistics, and Soc 802: Sociological Methods II, Research Design.

3) An additional 4 credits of electives, in or outside of home economics.

4) Before the second semester of graduate study, students will have planned a program of studies with the approval of their advisory committees.

5) A final oral and/or written examination.

## 707. PRACTICUM IN HOME ECONOMICS

Supervised in-depth experience with observation and participation to increase the student's understanding in a specific area of home economics. Choice of practicum from A) Child; B) Family; C) Consumer; D) Food and Nutrition. Prereq: HEc major; permission. 4 cr.

## 709. BIOCHEMISTRY OF NUTRITION

Intermediary metabolism of nutrients and energy; metabolism transport mechanisms; biological oxidations; interrelationships of carbohydrate, fat, and protein metabolism; obesity; control of hunger and appetite. Prereq: college course in biochemistry. (Also offered as AnSc 709.) 4 cr.

## 725. PRESCHOOL PROGRAMS

Organization of time, space, materials, and people to attain goals in early childhood programs. Historic and current programs. Prereq: preschool methods and materials or permission. 4 cr.

## 727. STUDENT TEACHING IN THE PRESCHOOL-KINDERGARTEN

Supervised teaching experience. Students spend 14 weeks, 18-20 hours per week, in a selected preschool, working with a cooperating teacher. The student must apply at least one semester previous to the semester in which he or she plans to student teach. Prereq: permission. Coreq: HEc 728. 6 cr. Cr/F. (Spring semester only.)

## 728. SEMINAR FOR STUDENT TEACHERS IN THE PRESCHOOL-KINDERGARTEN

Students will enrich their student teaching experience with biweekly seminars throughout the semester as a supplement to their practical experience in the field. Prereq: permission. Coreq: HEc 727. 2 cr. (Spring semester only.)

## 751. CONSUMER DECISION MAKING

Examination of individual and group consumer decision-making strategies and styles, including information acquisition, information processing, negotiation, and power. Prereq: management and decision making or equivalent; permission. 4 cr.

## 752. FAMILY ECONOMICS

The effect of economic change on families and family income and resource allocation. Prereq: one course in economics or permission. 4 cr.

## 756. CONSUMERS IN SOCIETY

Examination of problems and issues facing selected groups of consumers, e.g., the elderly, the poor,

children and adolescents, women, etc. Prereq: 3 courses in consumer studies or permission. 4 cr.

## 773. NUTRITION AND HUMAN DEVELOPMENT

Functional role of nutrients in physiological and biochemical systems and their importance in human growth, development, and behavior. Prereq: nutrition in health and disease, or permission. 4 cr. (Fall semester only.)

## 774. CLINICAL DIETETICS

Principles of normal nutrition applied to clinical problems; altered nutrient requirements in human disease. Diet therapy as applied to clinical nutrition. Prereq: prin of nutrition; human nutrition; biochemistry; permission. 4 cr. (Spring semester only.)

## 776. CONTEMPORARY ISSUES IN NUTRITION

Focus on national and worldwide nutrition concerns. Approaches and materials used in nutrition education. Prereq: basic nutrition course; permission. 4 cr. (Spring semester only.)

## 786. DYNAMICS OF FAMILY CHANGE

Theories and research for the assessment of family interaction patterns; planned intervention techniques. Students examine their interaction processes and their possible effect on intervention efforts. Prereq: family relations; clinical approaches to human behavior. 4 cr.

## 791. METHODS OF TEACHING HOME ECONOMICS

Home economics in the school program; curriculum materials, methods, and resources in teaching. 4 cr.

## 793. FAMILY LIFE EDUCATION

Critical review of current issues and literature; materials and methods for programs such as sex education and parent education. Prereq: family relations; permission. 4 cr.

## 797. SPECIAL TOPICS IN CONSUMER STUDIES

Highly focused examination of a particular theoretical, methodological, or policy issue in consumer studies. Prereq: three courses in consumer studies or permission. 4 cr.

## 804. PROTEIN METABOLISM AND NUTRITION

Metabolism of dietary amino acids in the mammalian system with emphasis on various aspects of protein nutrition. Prereq: permission. (Also offered as AnSci 804.) Mr. Schwab. 4 cr. (Not offered every year.)

## 810. MINERALS AND VITAMINS IN NUTRITION

Metabolism and function of mineral elements and vitamins in higher animals. Prereq: permission. (Also offered as AnSci 810.) Mr. Parsons. 4 cr. (Not offered every year.)

## 874. CLINICAL NUTRITION AND ASSESSMENT

Changes in physiological and/or biochemical functions or processes due to illness and uses of modified diets as an essential part of nutritional

assessment and treatment. Prereq: HEc 773 or permission. 4 cr. (Not offered every year.)

### **876. CURRENT ISSUES IN COMMUNITY NUTRITION**

Controversial issues in nutrition are the focus for discussion of the improvement and maintenance of the health status of individuals and groups; techniques of data evaluation, interpretation, and nutrition education are emphasized. Prereq: HEc 773, 774, or permission. 4 cr. (Spring semester only.)

### **883. AMERICAN FAMILIES IN POVERTY**

Problems of economically deprived rural and urban families. Objective, intellectual, and human involvement in dealing with poor families. Understanding the strengths and weaknesses typical of American families in poverty. 4 cr.

### **886. CRITICAL PROBLEMS IN FAMILY LIFE**

Evaluation of the needs and resources of families with critical problems; maturational and situational sources of stress influencing the contemporary American family; students will demonstrate mastery of theoretical concepts by developing self-help strategies to be used by families experiencing stress. Prereq: permission. 4 cr.

### **893. PARENTS AND CHILDREN**

In-depth study of the reciprocal relationships among parents and children. Evaluation of service programs in terms of current research. Prereq: the young child, family relations, or permission. 4 cr.

### **895. SEMINAR AND SPECIAL PROBLEMS**

B) Consumer Studies; C) Family Relations; D) Food and Nutrition; E) Home Economics Education; F) Management and Family Finance; and G) Human Development. The student will contribute to a selective review and critical evaluation of the research and current literature and an examination of issues and trends. Independent projects may be a part of the experience. These seminars are open to graduate students with sufficient background and will not be scheduled every semester. One or more semesters, maximum of 4 credits in one area. 2-4 cr.

### **897. RESEARCH SEMINAR**

Interdisciplinary approach to research in home economics. Emphasis on the multidimensionality of family problems, appropriate research strategies, and critical analysis of current literature. 4 cr.

### **898. RESEARCH PROJECT**

A study or project which may be selected in lieu of a thesis (students admitted prior to September, 1982, only). To be taken concurrently with or following HEc 897. 2-4 cr.

### **899. MASTER'S THESIS**

6 cr.

## **Institute of Natural and Environmental Resources**

**Director:** Owen B. Durgin

**PROFESSORS:** Richard A. Andrews; James P. Barrett; Gordon L. Byers; William H. Drew; Owen B. Durgin; Nicolas Engalichev; Francis R. Hall; John L. Hill; Harold W. Hocker, Jr.; Edmund F. Jansen, Jr.; William Mautz; David P. Olson

**ASSOCIATE PROFESSORS:** John E. Carroll; S. Lawrence Dingman; Robert D. Harter; Bruce E. Lindsay; Albert E. Luloff; Nobel K. Peterson; R. Marcel Reeves; Richard R. Weyrick

**ASSISTANT PROFESSORS:** Robert T. Eckert; Peter H. Greenwood; Theodore E. Howard; Donald R. Miller

**ADJUNCT PROFESSORS:** George E. Frick; Nelson L. LeRay, Jr.; Robert S. Pierce

**ADJUNCT ASSOCIATE PROFESSORS:** C. Anthony Federer; James W. Hornbeck; William B. Leak; Sidney A. L. Pilgrim; Betty H. Roberts; Lawrence O. Safford; Charles F. Tucker

**ADJUNCT ASSISTANT PROFESSORS:** Maurice E. Demeritt, Jr.; Peter W. Garrett

**GRADUATE PROGRAM COORDINATOR:** Robert D. Harter

### ***Master of Science, Natural and Environmental Resources***

A single master's degree is offered by the Institute with six specific options:

**Forest Resources:** Forest resource management; forest recreation; forest marketing; wood industry management; forest mensuration; forest tree improvement; and wood science and technology.

**Hydrology:** Water quality; ground water hydrology; surface water hydrology; and water resource management.

**Resource Economics:** Agricultural economics; community development; regional economics; land and water economics; rural manpower; and marine economics.

**Soil Science:** Soil chemistry; soil classification and genesis; soil microbiology; and forest soils.

**Resource Administration and Management:** Management of publicly and privately owned natural resources; administration of natural resource laws and policies; management of natural-resource-based firms.

**Wildlife Ecology:** Habitat evaluation and management; wildlife nutrition and physiology; and land-use planning for wildlife.

### ***Entrance Requirements***

Students admitted to Institute programs in these options are expected to have completed either an undergraduate degree in the field in which they plan to specialize or show adequate preparation in the basic support courses of the field. Students with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. The Graduate Record Examination is required of all applicants.

Students entering the forest resources option are usually expected to have completed a bachelor's degree in forestry equivalent to that obtained at a

school accredited by the Society of American Foresters. Students planning for the resource economics option will need satisfactory undergraduate training that would usually be expected to include four or more courses in economics or resource economics. Entering students in hydrology and soil science are required to have adequate preparation in chemistry, physics, mathematics (including, for hydrology, one year of calculus), and the biological or earth sciences. Students interested in wildlife ecology are expected to have adequate preparation in biological sciences, chemistry, and mathematics including statistics. Students interested in resource administration and management are expected to have had a minimum of three courses in the areas of ecology or natural resources, and resource economics, or be expected to make up this deficiency. This option is designed primarily for persons having professional experience in resource administration, management, or related areas; applicants are requested to submit an essay of up to 5,000 words describing their backgrounds and goals.

### **Academic Requirements**

The M.S. degree is conferred upon successful completion of the following:

- 1) A program amounting to not less than 30 credits (34 credits for Res. Admin. and Mgt.), including the following course requirements or equivalent: INER 893-894 seminar, 2 cr.; INER 803, Approach to Research, 2 cr.; quantitative methods or analytical techniques, 3-4 cr.; and INER 898, Directed Research, 4-6 cr. or INER 899, Thesis, 6-10 cr.
- 2) A final oral and/or written examination.

### **Intercollege Cooperative Programs**

The Institute participates in four doctoral degree programs on a cooperative basis with other departments in the University. The Department of Chemistry offers a soil and water chemistry option in its Ph.D. program, which is coordinated through joint efforts of the soils and hydrology faculties and the chemistry faculty (see Interdisciplinary Options and Programs). A Ph.D. program in genetics is available to students in forest resources through the Genetics Program (see Genetics Program). Students can earn a Ph.D. in economics in the cooperative program between resource economics and the Whittemore School of Business and Economics (see Economics). Through informal cooperative arrangements with the electrical and mechanical engineering departments, opportunities are available for graduate study in wood science and technology in the College of Engineering and Physical Sciences, leading to either the master's degree in electrical engineering or mechanical engineering or the Ph.D. degree in engineering (see Engineering Ph.D. Program: Theoretical and Applied Mechanics or Signal Processing).

### **Natural and Environmental Resources (INER)**

#### **701. STATISTICAL METHODS I**

Analysis of variance and general linear models; measured numbers, nature of statistical evidence, sampling distributions, and principles of statistical inference; application of specific linear models to given sets of data. Prereq: upper-division under-

graduate or graduate standing. Mr. Durgin. 4 cr. (Not offered every semester.)

#### **702. NATURAL RESOURCES POLICY**

Contemporary issues in the management and allocation of natural resources; effect of humans on agricultural and forest lands, water, wildlife, fisheries, and minerals; historical perspective of current resource policies. Prereq: permission. Mr. Carroll. 4 cr.

#### **709. SOILS AND COMMUNITY PLANNING**

Using a town plan and soils map, students develop reports for multiple urban and rural land-use-housing, sewage, recreation, transportation, runoff, etc. USDA soil classification system; Soil Conservation Service rating criteria; New Hampshire soils. Guest lecturers. Prereq: permission. Mr. Peterson. 2 cr.

#### **711. STATISTICAL METHODS II**

Intermediate course in statistics; basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangement of treatments, multiple regression, and covariance. Computer programs used in analyzing data. Examples from environmental sciences. Prereq: applied statistics I; /or equivalent. Mr. Barrett. 4 cr.

#### **712. SAMPLING TECHNIQUES**

Techniques of sampling finite populations in environmental sciences; choice of sampling unit and frame, estimation of sample size, confidence limits, and comparisons of sample designs. Prereq: applied statistics I; /or equivalent. Mr. Barrett. 2-4 cr.

#### **713. QUANTITATIVE ECOLOGY**

Applied quantitative techniques: basic concepts in probability and statistics applied to ecological systems; population dynamics; spatial patterns; species abundance and diversity; classification and ordination; production; and energy and nutrient flow. Additional credit for in-depth mathematical analysis of a particular topic. Prereq: introductory courses in calculus, statistics, and ecology. Mr. Barrett. 3 or 4 cr.

#### **718. LAW OF NATURAL RESOURCES AND ENVIRONMENT**

For resource managers: the legal system pertaining to resource management, protection of the environment, and possibilities for future action. Prereq: contemp conserv issues, or land economics and use, or permission. Mr. Tucker. 3 cr.

#### **757. BASICS OF REMOTE SENSING**

Fundamentals for application of photographic and nonphotographic sensors to information gathering in natural resource fields; emphasis is on the interpretation of aerial photographs. Applications to forestry, wildlife, land-use planning, earth sciences, soils, hydrology, and engineering. Staff. Lab. 2 cr.

#### **758. APPLICATIONS OF REMOTE SENSING**

Applications of remote sensing to the student's disciplinary interest. Student projects developed using available conventional aerial photography or other imagery. Prereq: INER 757; /or equivalent. Transportation fee. Staff. Lab. 2 cr.

**795, 796. INVESTIGATIONS**

A) Resource Administration; B) Resource Management; C) Resource Policy; D) Public Laws and Resources. May be repeated. Prereq: permission. Staff. 2-4 cr.

**797. FOREST RECREATION SEMINAR**

Recreational use of nonurban lands; economics of public and private developments; planning for state and private recreational use, social aspects. Class project. Prereq: permission. Staff. 4 cr.

**803. APPROACH TO RESEARCH**

The meaning of science and the application of logic in the scientific method. Principles and techniques of scientific research. Survey of experimental design procedures. Organization of investigative work, problem analyses, working plans, and scientific writing. Prereq: permission. Staff. 2 cr.

**811. NATURAL AND ENVIRONMENTAL RESOURCE MANAGEMENT**

To develop an understanding of the fundamental scientific, aesthetic, and ethical principles involved in the management of renewable natural resources and ways to apply these principles in the formulation and evaluation of resource-management policies including the identification of unifying concepts in the management of specific renewable resources, soils, water, forests, and wildlife. Prereq: permission. Staff. 4 cr.

**812. ADMINISTRATION OF RESOURCE LAWS AND POLICIES**

Largely devoted to legalistic, policy, and political science aspects of natural and community resource administration. Attention is also given to concepts of private property, home rule, social value, trade-offs, and bureaucracy as elements in administration. Transportation fee. Prereq: permission. Mr. Carroll. 4 cr.

**815. LINEAR PROGRAMMING METHODS**

Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications; nonlinear programming, discrete programming; and solving input-output and game-theory problems. Prereq: elem matrix alg or permission. Mr. Andrews. 2 cr.

**816. QUANTITATIVE FOREST ECOLOGY SEMINAR**

Preparation, presentation, and discussion of recent topics in quantitative ecology such as remote sensing, population growth, competition between species, modeling of a population, and energy flow. Seminar is 2 credits; an additional 2 credits available for an in-depth study of a particular topic. Mr. Leak and Mr. Barrett. 2-4 cr.

**893, 894. NATURAL AND ENVIRONMENTAL RESOURCES SEMINAR**

Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. 1 cr. Cr/F.

**898. DIRECTED RESEARCH**

Hours and credits to be arranged. Prereq: permission. Not available if credit obtained for INER 899. A year-long course; an "IA" grade (continuous

course) given at the end of the first semester. 2-6 cr. Cr/F.

**899. MASTER'S THESIS**

Hours and credits to be arranged. Prereq: Permission. 6-10 cr.

**Forest Resources (FoRs)**

**720. FOREST GENETICS**

Genetics of forest tree improvement; variation in natural populations, breeding methods, physiological characters, quantitative data analysis. Prereq: prin of genetics; silviculture; statistics; /or permission. Transportation fee. Mr. Eckert. Lab. 3 cr. (Not offered every year.)

**722. ADVANCED SILVICULTURE**

Intensive silviculture of forest stands. Regeneration (e.g., alternative regeneration methods and site preparation); stand management (e.g., thinning schedules and fertilization). Prereq: silviculture; permission. Transportation fee. Mr. Hocker. 3 cr. (Not offered every year.)

**734. FOREST PROTECTION SEMINAR**

Discussion and special problems based on principles and techniques of forest protection. Prereq: permission. Mr. Weyrick. 3 cr.

**737. GAME MANAGEMENT I**

Biological characteristics, habitat requirements, research and management practices of upland game birds and big game animals. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prereq: wildlife management major. Mr. Mautz. Lab. 4 cr.

**738. GAME MANAGEMENT II**

Biological characteristics, habitat requirements, research and management practices of small game animals, furbearers, and predators. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prereq: wildlife management major or permission. Mr. Miller. Lab. 4 cr.

**745. FOREST MANAGEMENT**

Forest land ownership; management objectives; forest inventory regulation and economic analysis; forest administration; professional responsibilities and opportunities. Transportation fee. Staff. Lab. 4 cr.

**753. OPERATIONS CONTROL AND ANALYSIS**

Quantitative tools for decision making in forest resource management activities; development and analysis of cost functions, timber and stumpage valuation, forecasting, linear programming. Monte Carlo simulation, PERT. Prereq: calculus; forest economics; statistics; mensuration. Mr. Howard. Lab. 4 cr.

**754. WOOD PRODUCTS**

**MANUFACTURE AND MARKETING**

Wood products from harvesting and procurement of raw material to finished product processes; management decisions, marketing, and promotion problems. All-day field trips to manufacturing plants and, occasionally, to associated harvesting operations, weather permitting. Transportation

fee. Prereq: wood sci. and tech.; or permission. Mr. Hill. Lab. 4 cr.

### **755. REGIONAL SILVICULTURE AND FOREST MANAGEMENT**

Extended field trip to another forest region. Prereq: FoRs 745; /or permission. Staff. (Limited enrollment.) 2 cr. Cr/F.

### **764/864. FOREST INDUSTRY ECONOMICS**

Business methods and economics in the forest industry; planning for minimum cost operations and profitable use of capital in a forest enterprise. Individual projects. Prereq: permission. Staff. 4 cr. (Not offered every year.)

### **798. FOREST RESOURCES MANAGEMENT SEMINAR**

The integration of demands from human population changes and needs on forest productivity through planning. The recognition of environmental quality and ecological concepts as planning criteria. Class discussions and group planning are a critical component. Prereq: FoRs 745. Staff. Lab. 4 cr.

### **801. FOREST MANAGEMENT SEMINAR**

Seminar discussions of current literature, plans, principles, and new developments in the general field of forest management. Transportation fee. Prereq: permission. Staff. 2 cr.

### **805. UTILIZATION SEMINAR**

Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. Prereq: permission. Mr. Hill. 2 cr.

### **806. OPERATIONS CONTROL SEMINAR**

Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of quantitative control of forest operations. Prereq: permission. Mr. Howard. 2 cr. (Not offered every year.)

### **809, 810. WILDLIFE MANAGEMENT SEMINAR**

Discussions and assigned reports on current investigations and developments in wildlife management. Prereq: undergraduate courses in wildlife management; permission. Mr. Olson. 1-4 cr.

### **895, 896. INVESTIGATIONS IN:**

A) Forest Ecology; B) Remote Sensing; C) Wood Utilization; D) Game Management; E) Mensuration; F) Forest Economics; G) Forest Management; H) Operations Control and Analysis; I) Recreation; J) Policy; K) Wildlife Physiology; L) Forest Genetics. Elective only after consultation with the instructor in charge. 1-4 cr.

## ***Hydrology (Hydr)***

### **705. PRINCIPLES OF HYDROLOGY**

Physical principles important in the hydrologic cycle, including: basic equations, properties of water, movement of water in natural environments, formation of precipitation, relations between precipitation and streamflow, snow-melt, evapotranspiration, interception, infiltration, relations between groundwater and streamflow, and

hydrologic aspects of water quality. Problems of measurement and aspects of statistical treatment of hydrologic data. Transportation fee. Prereq: calculus. Mr. Dingman. Lab. 4 cr.

### **710. GROUNDWATER HYDROLOGY**

Principles for fluid flow in porous media with emphasis on occurrence, location, and development of groundwater, but with consideration of groundwater as a transporting medium. Major topics include well hydraulics, regional groundwater flow, exploration techniques, and chemical quality. Laboratory exercises involve use of fluid, electrical, and digital computer models to illustrate key concepts. Prereq: calculus. Mr. Hall. Lab. 4 cr.

### **795, 796. INDEPENDENT WORK IN HYDROLOGY**

A) Hydrology; B) Chemistry of Water; C) Water Resource Management. Student may choose topic and faculty consultant. Staff. 1-4 cr.

### **803. ADVANCED HYDROLOGY**

Application of quantitative methods to selected hydrologic problems. Critical examination of deterministic and stochastic models, with emphasis on conceptualizing the hydrologic problem, developing appropriate models, obtaining solutions, and evaluating models and solutions in terms of basic assumptions, data requirements, and verification of results. Prereq: prin of hydrology; computer methods; basic statistics. Mr. Hall. 3 cr.

### **804. WATER QUALITY CONCEPTS AND MODELING**

Principles of chemical transport in fresh water and experience in modeling selected systems. Combination of literature review and application of existing models. Topics include the movement of phosphorus in lakes; oxygen and dyes in streams; and selected substances in ground water. Term project to be selected and implemented by each student. Prereq: physical chemistry, geochemistry, or soil chemistry or equivalent; computer methods; hydrology or limnology; or permission. Mr. Hall. 3 cr.

### **808. WATER RESOURCE MANAGEMENT**

Hydrologic and statistical aspects of water resource management; nature of water resource problems and application of models in their solution; geographical aspects of water-resource problems in the U.S.; economic, social, institutional, and environmental aspects of water resource problems. Prereq: prin of hydrology; basic statistics; /or permission. Mr. Dingman. 4 cr.

## ***Resource Economics (REco)***

### **705. PLANNED CHANGE IN NONMETROPOLITAN COMMUNITIES**

Discussion and application of community development theory and principles using appropriate research methodologies. Areas of study chosen from: population growth, community planning and development, provision and distribution of services, rural-urban difference, and systems management. Emphasis on empirical research studies. Students may participate in community-development activities. May include placement in field agency. Prereq: applied community development; statistics; permission. Mr. Luloff. 4 cr. (Offered in even years only.)

### **706. ECONOMICS OF RESOURCE DEVELOPMENT**

Resource scarcity and theories of economic development; major resource development problems of land and natural resources, urban-rural conflicting demands, and conservation and water supply; capital needs, externalities, and market failure. Prereq: intermediate economic theory. Mr. Jansen. 4 cr. (Offered every third semester.)

### **710. RESOURCE ECONOMICS SEMINAR**

A) Agricultural Economics and Food Policy; B) Rural Development; C) Marine Economics; D) Location of Economic Activity; E) Land and Water Economics; F) Quantitative Methods; G) Environmental Economics. In-depth treatment of area, including classic works. Seminars arranged to students' needs and offered as demand warrants. May be repeated. Staff. 2-4 cr.

### **717. LAW OF COMMUNITY PLANNING**

Common law and the Constitution with respect to property law, including eminent domain, land-use planning, urban renewal, and zoning. Makes the nonlawyer aware of the influence and operation of the legal system in community development. Mr. Tucker. 4 cr.

### **756. REGIONAL ECONOMIC ANALYSIS**

Concepts and methods of delineating regional economies, methods of measuring activity, regional development, and public policies. Emphasis on empirical research studies. Prereq: intermediate economic theory; /or permission. Mr. Lindsay. 4 cr. (Offered every third semester.)

### **804. APPLIED ECONOMICS OF RESOURCE USE**

The theory of resource allocation used in solving public and private economic problems. Resource-product relationships, nature of cost, returns to scale, factor valuation and pricing, and uncertainty are analyzed with appropriate methodology. Primary emphasis will be placed on empirical research studies and their implications. Prereq: applied statistics; intermediate microeconomic analysis. 4 cr. (Not offered every year.)

### **809. AGRICULTURAL ECONOMICS**

Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision making in food production, marketing, and consumption; the competitive structure of the food industry. 4 cr. (Not offered every year.)

### **820. ENVIRONMENTAL ECONOMICS SEMINAR**

The use of economic concepts for analyzing current environmental problems. Student reports and class discussion will deal with the application of economic analysis to real world environmental problems at the local, state, and national levels; costs and benefits of alternative methods of dealing with environmental objectives; and other economic goals of society. Prereq: intermediate micro- and macroeconomic analysis or equivalent; permission. Staff. 2 cr. (Not offered every year.)

### **838. INTRODUCTION TO THE LOCATION OF ECONOMIC ACTIVITY**

Economic theories explaining the behavior of individual firms and consumers in selecting sites for carrying on economic activities. The relationship

of these theories to patterns of industrial location, systems of cities, and land-use competition in general. Problems of locational change and adjustment and the effects of public policy on spatial economic activities. Prereq: elem calculus; linear algebra; regression; micro- and macroeconomics; /or permission. 4 cr. (Not offered every year.)

### **895-896. INVESTIGATIONS IN:**

A) Agricultural Marketing; B) Agricultural Production and Farm Management; C) Economics of Human Resources; D) Economics of Population and Food; E) Land Economics; F) Marine Economics; G) Rural Economic Development; H) Regional Economics; I) Water Economics. Special assignments in readings, investigations, or field problems. May be repeated. Prereq: permission. Staff. 2-4 cr.

### **Soil Science (Soil)**

#### **701. PHYSICS OF SOILS**

Soil as a physical system; textural and structural analysis of soils, water flow and retention, and heat and gas transfer; physical properties of soil and plant growth; methods of soil physical analysis. Prereq: soils and the environ or permission. Staff. Lab. 4 cr. (Not offered every year.)

#### **702. CHEMISTRY OF SOILS**

Chemical composition of soil; colloidal phenomena and the exchange and fixation of elements, cation exchange capacity and source of negative charge; inorganic reactions in soil and their effect on soil properties. Prereq: one year of college chemistry or permission. Mr. Harter. 3 cr.

#### **704. SOIL CLASSIFICATION AND MAPPING**

Soil genesis, morphology, classification, and mapping; major classification systems used in the U.S. and throughout the world as they relate to human uses of the soil. Prereq: soils and the environ; intro geology; /or permission. Transportation fee. Mr. Peterson. 4 cr.

#### **795, 796. INDEPENDENT WORK IN SOIL SCIENCE**

A) Soil-Plant Relationships; B) Physics of Soils; C) Chemistry of Soils; D) Soil Classification; E) Forest Soils. Prereq: permission. 1-4 cr.

#### **802. SPECIAL TOPICS IN SOIL SCIENCE**

Topics may include soil mineralogy, advanced soil chemistry, soil physical chemistry, or others as the need arises. Seminar or lecture format as appropriate to the topic. Prereq: permission. 1-3 cr. Cr/F. (Offered only with sufficient demand.)

#### **895-896. INDEPENDENT WORK IN SOIL SCIENCE**

A) Soil-Plant Relationships; B) Physics of Soils; C) Chemistry of Soils; D) Soil Classification; E) Forest Soils. Elective only after consultation with the instructor in charge. 1-4 cr.

### **Intercollege Course (Inco)**

#### **890. COLLEGE TEACHING**

Acquisition of theoretical and practical knowledge of the basics of college teaching; the role of the

college teacher in facilitating learning. Course participants will work to improve three aspects of their work: teaching methods with large and small groups, planning teaching sessions, and assessment of student learning. Participants will be encouraged to develop a teaching style that is effective and compatible with their philosophy, attitudes, and aptitudes. 2 cr. (Not offered every year.)

## Mathematics (Math)

**Chairperson:** Richard H. Balomenos

**PROFESSORS:** Richard H. Balomenos; Homer F. Bechtell, Jr.; David M. Burton; Arthur H. Copeland, Jr.; A. Robb Jacoby; Loren D. Meeker; Eric A. Nordgren; James Radlow; Shepley L. Ross; Albert O. Shar; Robert J. Silverman; Donovan H. Van Osdol

**ASSOCIATE PROFESSORS:** Albert B. Bennett, Jr.; William E. Bonnice; William E. Geeslin; Donald W. Hadwin; Samuel D. Shore

**ASSISTANT PROFESSORS:** Kenneth B. Constantine; Marie A. Gaudard

**GRADUATE PROGRAM COORDINATOR:** Samuel D. Shore

### Master of Science for Teachers

**Admission Requirements:** Completion of all requirements for secondary school teacher certification in mathematics.

**Degree Requirements:** 1) Ten semester courses approved by the department. These will normally be taken from the courses numbered 801-829 and will usually include the six courses numbered 803-808. 2) A comprehensive examination based primarily on material in courses 803-808. It is not possible to study full time during the academic year toward the Master of Science for Teachers degree. The courses in this program are offered primarily in summer institutes.

### Master of Science in Mathematics

**Admission Requirements:** A year of algebra or a year of analysis. Preference will be given to applicants who have completed both these sequences.

**Degree Requirements:** Ten semester courses approved by the department. These must be chosen from courses numbered 701-799 or 830-849. At least six of the ten must be from the 830-849 group. An oral comprehensive examination is required.

### Doctor of Philosophy

The department offers the Ph.D. under two labels: mathematics and mathematics-education. (A detailed description of the Ph.D. program is available from the department.) These programs have a common core as follows:

**Admission Requirements:** same as for the Master of Science in Mathematics.

**Basic Degree Requirements:** 1) all of the courses numbered 833-839; 2) experience in teaching equivalent to at least half-time for one year; and 3) written comprehensive examination; this involves algebra, analysis (real and complex), and general topology, and should be taken after three semesters in residence.

**Additional Degree Requirements for the Ph.D. in Mathematics:** 4) proficiency in reading mathematical literature in two of three languages: French, German, and Russian; 5) advanced work in a major (the field of the thesis) and a minor (usually another field of mathematics), with an oral examination in these two fields; and 6) thesis—new and original mathematical results will be required. Thesis work is available in algebra, applied mathematics, statistics, analysis, and topology.

**Additional Degree Requirements for the Ph.D. in Mathematics-Education:** 4) language requirement as in Ph.D. in mathematics except that mastery of an approved research tool may be substituted for one language; 5) advanced work in a major (mathematics-education) and a minor (usually education) with an oral examination in these two fields; 6) thesis—new and original results involving pedagogical problems in mathematics will be required.

*A maximum of four of the following courses may be applied to the degree of Master of Science in mathematics.*

#### 735. PROBABILITY

Sample spaces (discrete and continuous); random variables; conditional probability; moments; binomial, Poisson, and normal distributions; limit theorems for sums of random variables. Prereq: multidim calculus. 4 cr.

#### 736. STATISTICS

Sampling theory, parameter estimation, hypothesis testing, regression, analysis of variance, nonparametric methods. Prereq: Math 735. 4 cr.

#### 737. DECISION THEORY AND BAYESIAN METHODS

Utility, decision problems, prior and posterior distributions, sufficiency, estimation and hypothesis testing, linear models, and sequential sampling. Emphasis on applications to business and economics. Prereq: Math 735. (Also offered as Econ 737.) 4 cr. (Offered in alternating years.)

#### 738. MULTIVARIATE STATISTICAL ANALYSIS

Multivariate distributions, estimation and hypothesis testing, principal components, canonical correlations, factor analysis, discriminant analysis. Prereq: Math 735 and 762. 4 cr. (Offered in alternating years.)

#### 739. LINEAR STATISTICAL MODELS

Estimation, testing, and diagnostic methods for linear regression, analysis of variance, and analysis of covariance. Some experience in the use of packaged statistical computer programs. Prereq: statistics and linear algebra. 4 cr. (Offered in alternating years.)

#### 740. NONPARAMETRIC STATISTICAL METHODS

Methods of nonparametric statistical inference for one-sample and two-sample problems, one-way and two-way layouts, correlation, and regression. Prereq: statistics. 4 cr. (Offered in alternating years.)

#### 745-746. FOUNDATIONS OF APPLIED MATHEMATICS

Basic concepts and techniques of applied mathe-

matics intended for graduate students of mathematics, engineering, and the sciences. Fourier series and transforms, Laplace transforms, optimization, linear spaces, eigenvalues, Sturm-Liouville systems, numerical methods, conformal mapping, residue theory. 4 cr.

### **753. NUMERICAL METHODS AND COMPUTERS I**

Use of scientific subroutine and plotter-routine packages, floating point arithmetic, polynomial and cubic spline interpolation, implementation problems for linear and nonlinear equations, random numbers and Monte Carlo method, Romberg's method, optimization techniques. Selected algorithms will be programmed for computer solution. Prereq: calculus II; intro programming and FORTRAN. (Also offered as C S 753.) 4 cr.

### **754. NUMERICAL METHODS AND COMPUTERS II**

Mathematical software. Computer solutions of differential equations, eigenvalues and eigenvectors. Prereq: intro programming and FORTRAN. (Also offered as C S 754.) 4 cr.

### **761. ABSTRACT ALGEBRA**

Basic properties of groups, rings, fields and their homomorphisms. 4 cr.

### **762. LINEAR ALGEBRA**

Abstract vector spaces, linear transformations and matrices. Determinants, eigenvalues and eigenvectors. Prereq: Math 761. 4 cr.

### **764. ADVANCED ALGEBRA**

Topics to be selected from among rings, modules, algebraic fields, and group theory. Prereq: Math 761. 4 cr. (Offered in alternating years.)

### **767. ONE-DIMENSIONAL REAL ANALYSIS**

Theory of limits, continuity, differentiability, integrability. 4 cr.

### **768. ABSTRACT ANALYSIS**

Metric spaces, function spaces, theory of uniform limits. Prereq: Math 767. 4 cr. (Offered in alternating years.)

### **769. MULTIDIMENSIONAL REAL ANALYSIS**

Continuity and differentiability of mappings from n-space to m-space; multiple integrals; line and surface integrals. Prereq: Math 767; Math 762. 4 cr. (Offered in alternating years.)

### **776. LOGIC**

Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. 4 cr. (Offered in alternating years.)

### **783. SET THEORY**

Axiomatic set theory, including its history, Zermelo-Fraenkel axioms, ordinal and cardinal numbers, consistency, independence, and undecidability. 4 cr. (Offered in alternating years.)

### **784. TOPOLOGY**

Open sets, closure, base, and continuous functions. Connectedness, compactness, separation axioms, and metricizability. 4 cr.

### **785. ALGEBRAIC METHODS IN TOPOLOGY**

Introduction to some methods of algebraic topology from topology of manifolds, homology theory, knot theory. Prereq: Math 784 and/or Math 761. 4 cr. (Offered in alternating years.)

### **788. COMPLEX ANALYSIS**

Complex functions, sequences, limits, differentiability and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, conformal mapping. Prereq: Math 767. 4 cr.

### **791. MATHEMATICS EDUCATION**

Methods of teaching mathematics in junior and senior high school; acquaintance with professional organizations and publications; and review of major curriculum projects. Prereq: exploring teaching. 4 cr.

*The following courses may be applied to the degree of Master of Science for Teachers in mathematics and to no other degree in mathematics.*

### **801-802. MATHEMATICS AND COMPUTING FOR TEACHERS**

An introductory course designed to familiarize the students with the capabilities of a computer and to enable them to use it confidently. Applications to algebra, analysis, logic, and game theory are examined. 3 cr.

### **803-804. HIGHER ALGEBRA FOR TEACHERS**

The integers, integral domains, and topics from number theory; equivalence relations and congruences; real numbers, complex numbers, fields, and polynomials; group theory; matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 cr.

### **805-806. HIGHER GEOMETRY FOR TEACHERS**

Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry and topology. 3 cr.

### **807-808. HIGHER ANALYSIS FOR TEACHERS**

The real number system; functions and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. 3 cr.

### **809. PROBABILITY AND STATISTICS FOR TEACHERS**

Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 cr.

### **810. MATHEMATICS EDUCATION**

Current developments and issues in mathematics education; content, curricula, methods, and psychology of teaching mathematics. 1-4 cr.

### **811. COMPUTERS AND THEIR USES**

3 cr.

### **814. TOPOLOGY FOR TEACHERS**

Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 cr.

**816. THEORY OF NUMBERS FOR TEACHERS**

Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; perfect and amicable numbers. 3 cr.

**817. THEORY OF SETS AND ELEMENTARY LOGIC**

An introduction. 3 cr.

**819. THE REAL NUMBER SYSTEM**

A postulational approach. Algebraic structure; sequences, limits, and continuity. 3 cr.

**820. HISTORY OF MATHEMATICS**

A problem-study approach to mathematical problems from the period of Greek mathematics until the modern era. 3 cr.

**821. A MODERN APPROACH TO GEOMETRY**

The foundations and development of Euclidean geometry, with emphasis on the recent recommendations in the field of high school geometry. 3 cr.

**826. SELECTED TOPICS IN ALGEBRA**

Topics selected to supplement the teacher's previous training in algebra, chosen from among the following: linear algebra, vector spaces, groups, rings and ideals, and fields. 3 cr.

**827. SELECTED TOPICS IN GEOMETRY**

Topics selected to supplement the teacher's previous training in geometry, chosen from among the following: analytic projective geometry, non-Euclidean geometry, transformation theory, elementary metric differential geometry, topology. 3 cr.

**828. SELECTED TOPICS IN ANALYSIS**

Topics selected to supplement the teacher's previous training in analysis, chosen from among the following: sequences and series of real functions, Riemann integration, partial differentiation, complex functions, differential equations. 3 cr.

**829. DIRECTED READING**

A directed reading project on a selected topic in mathematics. 3 cr.

*The following are the basic courses for both the Master of Science and Doctor of Philosophy degrees in mathematics.*

**833-834. ALGEBRA**

Groups; rings, modules; fields; linear algebra. Prereq: undergrad abstract algebra. 3 cr.

**835. MEASURE AND INTEGRATION**

Outer measures and measures; Lebesgue integrals; convergence theorems. Prereq: undergraduate real analysis. 3 cr.

**836. FUNCTIONAL ANALYSIS**

Banach spaces; representation of linear functionals; weak and weak\* topologies. Prereq: Math 835. 3 cr.

**837. COMPLEX ANALYSIS**

Open mapping theorem; maximum modulus theorem; normal families and Riemann mapping theorem; harmonic functions; representation theorems; analytic continuation. Prereq: undergrad complex analysis. 3 cr.

**838. ALGEBRAIC TOPOLOGY**

Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products. Prereq: undergrad abstract algebra and topology. 3 cr.

**839. GENERAL TOPOLOGY**

Subspace, product, and quotient topologies; embedding; separation and countability axioms; connectedness; compactness and compactifications; paracompactness, metrization, and metric completions. Prereq: undergrad general topology. 3 cr.

*The following more specialized courses are offered on an irregular schedule whenever mutual faculty and student interest justifies it. Content will vary from year to year and will normally be chosen from among the topics listed. With the permission of the instructor, each of these courses may be taken more than once for credit.*

**841. TOPICS IN LOGIC AND FOUNDATIONS**

Recursive functions; independence proofs; models; forcing techniques. 3 cr.

**842. TOPICS IN ALGEBRA**

Homological algebra; algebraic number theory; local algebra; category theory; group theory; ring theory; field theory. 3 cr.

**843. TOPICS IN TOPOLOGY**

Topological groups; algebraic topology; general topology. 3 cr.

**844. TOPICS IN ANALYSIS**

Calculus of variations; harmonic analysis; integral equations; operator theory; linear topological spaces; partially ordered spaces; topological algebras; complex variables. 3 cr.

**845. TOPICS IN DIFFERENTIAL EQUATIONS**

Linear systems; general autonomous systems; two-dimensional systems; boundary value problems; qualitative theory; stability theory; partial differential equations; functional analytic methods. 3 cr.

**846. TOPICS IN APPLIED MATHEMATICS**

Distribution theory; potential theory; mechanics; control theory; mathematical biology; model theory; operations research. 3 cr.

**847. TOPICS IN MATHEMATICS EDUCATION**

The psychology of teaching and learning mathematics; supervision in mathematics teaching; curriculum theory; new curriculum projects; curriculum evaluation. 3 cr.

**848. TOPICS IN GEOMETRY**

Analysis on manifolds; differential geometry; Riemannian geometry; algebraic geometry; convexity. 3 cr.

**849. TOPICS IN PROBABILITY AND STATISTICS**

Time series analysis; analysis of variance; stochastic processes; probability; design of experiment; hypothesis testing; estimation theory; nonparametric statistics. 3 cr.

*The following courses are introductions to research opportunities for Doctor of Philosophy candidates. With the permission of the instructor, each of these courses may be taken more than once for credit.*

**861, 862. ADVANCED TOPICS IN ALGEBRA**

3 cr.

**865, 866. ADVANCED TOPICS IN GENERAL TOPOLOGY**

3 cr.

**867, 868. ADVANCED TOPICS IN ALGEBRAIC GEOMETRY**

3 cr.

**869, 870. ADVANCED TOPICS IN FUNCTIONAL ANALYSIS**

3 cr.

**871, 872. ADVANCED TOPICS IN ALGEBRAIC TOPOLOGY**

3 cr.

**873, 874. ADVANCED TOPICS IN APPLIED MATHEMATICS**

3 cr.

**879, 880. ADVANCED TOPICS IN MATHEMATICS EDUCATION**

3 cr.

**898. READING COURSES**

A) Algebra; B) Analysis; C) Topology; D) Geometry; E) Functional Analysis; F) Differential Equations; G) Applied Mathematics; H) Probability and Statistics; I) Mathematics Education. 1-6 cr.

**999. DOCTORAL RESEARCH**

## **Mechanical Engineering (M E)**

**Chairperson:** Russell L. Valentine

**PROFESSORS:** Robert W. Corell; Godfrey H. Savage; Charles K. Taft; Russell L. Valentine; Asim Yildiz

**ASSOCIATE PROFESSORS:** E. Eugene Allmendinger; Wayne M. Beasley; Barbaros Celikkol; Frederick G. Hochgraf; David E. Limbert; Harvey Lyons; William Mosberg; M. Robinson Swift; John A. Wilson

**GRADUATE PROGRAM COORDINATOR:**  
Wayne M. Beasley

The mechanical engineering department offers programs of study from the viewpoint both of the engineering sciences and of engineering design, in the areas of mechanics, materials science, automatic control, and the thermal sciences, leading to the degree of Master of Science in Mechanical Engineering. The programs provide the background required for careers in research, engineering design, or teaching, or for further graduate study.

Students admitted to graduate study in mechanical engineering should have completed work equivalent to that required by the University of

New Hampshire for a Bachelor of Science degree in the field.

A candidate for the degree of Master of Science shall satisfy the requirements of either a thesis plan or a project plan. The thesis plan requires 24 semester hours of coursework in addition to M E 899, Master's Thesis; the project plan requires 30 semester hours of coursework in addition to M E 892, Master's Project. At least eight credits must be earned in 800-level courses other than M E 892 Master's Project and M E 899 Master's Thesis. No more than two graduate courses taken prior to admission to the Graduate School may be applied to the master's degree. An oral examination covering the candidate's graduate work will be given, for both the thesis and project plans.

Students interested in graduate study beyond the master's degree should refer to the interdepartmental Engineering Ph.D. Program, which includes the following areas of specialization: engineering systems design, signal processing, theoretical and applied mechanics, and transport phenomena. For details refer to the section entitled Engineering Ph.D. Program.

Permission of the instructor and consent of the adviser are required for enrollment in all mechanical engineering graduate courses.

**701. MACROSCOPIC THERMODYNAMICS**

Thermodynamic principles using an analytic, postulational approach and Legendre transformations to obtain thermodynamic potentials. 4 cr.

**702. STATISTICAL THERMODYNAMICS**

Macroscopic thermodynamic principles developed by means of microscopic analysis. Prereq: thermodynamics. 4 cr.

**703. HEAT TRANSFER**

Analysis of phenomena; steady-state and transient conduction, radiation, and convection; engineering applications. Co- or prereq: fluid dynamics. 3 cr.

**707. ANALYTICAL FLUID DYNAMICS**

Development of the Navier-Stokes equations; vorticity theorems; turbulence and boundary-layer theory. Prereq: fluid dynamics. 4 cr.

**708. GAS DYNAMICS**

Basic equations of motion of one-dimensional, subsonic and supersonic flows of compressible, ideal fluids. Wave phenomena. Rankine-Hugoniot relations. Linear approach to two-dimensional flow problems. Prereq: fluid dynamics. 4 cr.

**710. SOLAR HEATING SYSTEMS**

Analysis and computer modeling of solar radiation as an energy source for heating. Phenomena, availability, collection, performance, and economy of solar energy for heating systems. Prereq: M E 703. 3 cr.

**717. CRYOGENICS**

Phenomena and processes at very low temperatures. Basic engineering sciences applied to problems of low temperature refrigeration, liquefaction, separation, and storage; transport of cryogenic

fluids; measurement systems; vacuum technology. Prereq: thermodynamics, 4 cr.

### **723. ADVANCED DYNAMICS**

Classical dynamics oriented to contemporary engineering applications. Review of particle dynamics. Hamilton's principle and the Lagrange equations. Kinematics and dynamics of rigid bodies, gyroscopic effects in machinery and space structures. 4 cr.

### **724. VIBRATION THEORY AND APPLICATIONS**

Discrete vibrating systems. Linear system concepts; single-degree-of-freedom systems with general excitation. Matrix theory and eigenvalue problems. Many degrees of freedom, normal mode theory for free and forced vibration. Numerical methods; introduction to continuous systems; applications to structural and mechanical systems. Prereq: intro vibrations. 4 cr.

### **726. EXPERIMENTAL MECHANICS**

Experimental methods and theoretical bases applied to measurement of stress, strain, and motion. Transmitted and scattered-light photoelasticity; strain gauge applications; brittle coating and grid techniques; dynamic measurements, and associated instrumentation. 4 cr.

### **727. ADVANCED MECHANICS OF SOLIDS**

Beams on elastic foundation, curved bars, inelastic behavior, instability, introduction to thin plates and shells, introduction to elasticity, energy methods, and numerical methods. 4 cr.

### **730. MECHANICAL BEHAVIOR OF MATERIALS**

Elastic and inelastic behavior of materials in terms of micro- and macromechanics. Stress, strain, and constitutive relations related to recent developments in dislocation theory and other phenomena on the atomic scale and to the continuum mechanics on the macroscopic scale. Elasticity, plasticity, viscoelasticity, creep, fracture, and damping. Anisotropic and heterogenous materials. 4 cr.

### **737. OCEAN MECHANICS I**

Ocean as a continuous medium, its mechanical and thermodynamic properties. Shallow- and deep-ocean modeling for the investigation of gravity and sound waves. Ocean subbottom and its soil mechanical and sound propagation properties. Instrumentation, rudimentary data collecting and processing procedures, and computer usage. Prereq: fluid dynamics; mechanics; diff eqns; multidim calculus. 4 cr.

### **738. OCEAN MECHANICS II**

Ocean dynamical laws generalized to include temperature and salinity variations in the water column. Conservation laws with generalized equation of state. Air-sea interaction, energy transport phenomena, reflection from different coastal geometry, harbor resonances, internal currents. Sound reflection from subbottom, sound probing techniques to determine subbottom properties by ray theory and generalization of subbottom soil from an elastic to a viscoelastic medium. Prereq: M E 737; M E 781 desirable but not required. 4 cr.

### **741. FLUID CONTROL SYSTEMS**

Mathematical modeling of hydraulic, pneumatic, and fluidic control elements and control systems. Methods for: 1) analysis of systems using gases or liquids as the working fluid; 2) synthesis of the parameters of the control elements used in fluid control systems; 3) design of these systems. (Also offered as E E 741.) 4 cr.

### **751. NAVAL ARCHITECTURE IN OCEAN ENGINEERING**

Selected topics in the fundamentals of naval architecture pertinent to ocean engineering, including hydrostatic characteristics, basics of resistance and propulsion and rules and regulations for surface, semisubmersible, and submersible marine vehicles. Computer applications. Prereq: fluid dynamics; mechanics; /or permission. 4 cr.

### **752. SUBMERSIBLE VEHICLE SYSTEMS DESIGN**

Conceptual and preliminary design of submersible vehicle systems; submersibles, environmental factors, hydromechanic and structural principles, materials, intra/extravehicle systems, operating considerations, predesign and design procedures. Design projects selected and completed by student teams. Prereq: permission. 4 cr.

### **757. COASTAL ENGINEERING AND PROCESSES**

Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. 3 cr.

### **760. PHYSICAL METALLURGY I**

Introduction to the electron theory of metals, intermetallic compounds, ferromagnetism, dislocations, and slip phenomena. 4 cr.

### **761. X-RAY DIFFRACTION**

Physics of x-ray diffraction, the reciprocal lattice, lattice parameter determinations, space group identification, phase identification, characterization of preferred orientation. Lab. 4 cr.

### **763. MICROSTRUCTURE OF SOLIDS**

Basic concepts and measurements; statistically exact expressions for points, lines, surfaces, and volumes; random, partially oriented and oriented structures; particle and grain characteristics and distributions; projected images and shape specification; practical applications. 4 cr.

### **766. PHYSICAL CERAMICS**

Characteristics of crystalline and noncrystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation and crystal growth, spinodal decomposition, and solid-state reactions; kinetics of grain growth; sintering, and vitrification. Prereq: permission. 4 cr.

### **771. DYNAMIC SYSTEMS MODELING**

Lumped parameter models for mechanical, electrical, fluid, thermal, and fixed systems. Time-domain solutions, frequency-response plots, matrix representations, eigen vectors, and eigenvalues are used to explore system response. Introduction to nonlinear analysis, simulation, computer applications. 3 cr.

## **781. MATHEMATICAL METHODS IN ENGINEERING SCIENCE I**

Solution of discrete and continuous systems. Review of calculus, linear algebra, complex numbers, Fourier series, differential and partial differential equations with examples from acoustics, vibration theory, hydrodynamics, elasticity, solid mechanics, transport theory, and particle mechanics. 4 cr.

## **782. CONTROL SYSTEMS**

Fundamental principles involved in the design and analysis of feedback control systems. Topics include stability criterion, time-domain analysis, frequency-domain analysis, and introduction to nonlinear systems. Lab. Prereq: permission. 4 cr. (Also offered as E E 782.)

## **793A-D-794 A-D. SPECIAL TOPICS IN ENGINEERING**

Course numbers refer to topics in A) Thermodynamics; B) Mechanics; C) Engineering Design; and D) Materials, respectively. Content of these courses may vary from year to year. 2-4 cr.

## **795A-D-796 A-D. INDEPENDENT STUDY**

Course numbers refer to topics in A) Thermal Science; B) Solid Mechanics; C) Engineering Design; and D) Materials, respectively. 2-4 cr.

## **801. IRREVERSIBLE THERMODYNAMICS**

Nonequilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prereq: M E 701. 4 cr.

## **803. CONDUCTION HEAT TRANSFER**

Heat conduction equation temperature fields and heat flux vector; analytical solution of the conduction equation in several variables; initial and boundary value problems; numerical methods of solution. 4 cr.

## **804. RADIATION HEAT TRANSFER**

The fundamentals of radiant heat transfer. Development and solution of the wave equation for electromagnetic radiation. Analysis of Planck's law of radiation and earlier theories. Methods of solution of radiant interchange in real systems with and without absorbing media. 4 cr.

## **806. CONVECTION HEAT TRANSFER**

An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results. 4 cr.

## **807. COMPRESSIBLE FLUID FLOW**

General equations of motion for real and ideal compressible fluid flow including normal and oblique shocks, Prandtl Meyer flow, and methods of solutions. Applications to jet propulsion and turbo machinery. Prereq: M E 707 or 708. 4 cr.

## **808. THEORETICAL AERO/HYDRO-MECHANICS**

The mathematical development of the equations of frictionless fluid flow, using both tensor notation and various coordinate systems. Conformal mapping; Blasius theorem; Joukowski hypothesis; flow

around airfoils. Schwarz Christoffel theorem and vortex motion. 4 cr.

## **822. CONTINUUM MECHANICS**

Conservation laws for gases, liquids, and solids in a continuum are developed starting from Liouville and Boltzmann equations. Passage from a discrete system to a continuum is discussed. Constitutive equations for viscoelastic and thermoelastic fields; and nonlinear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases, and biomechanics. Introduction to phenomenological Lagrangian theories. 4 cr.

## **824. VIBRATIONS OF CONTINUOUS MEDIA**

Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods, transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 cr.

## **826. THEORY OF ELASTICITY**

The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; elastodynamic fields; inhomogeneous, anisotropic, wave equations; wave propagation and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques will be used. 4 cr.

## **827. THEORY OF PLASTICITY**

Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 cr.

## **829. THEORY OF PLATES AND SHELLS**

Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 cr.

## **838. THEORETICAL ACOUSTICS**

Fundamentals are presented with emphasis on theory and applications in underwater acoustics and in the acoustic determination of dynamic material properties. Topics include: a review of vibration theory; derivation of nonlinear acoustic field equations; linearization; Green's function techniques and solution of boundary value problems; scattering, reflection theories of boundary roughness; development of ray theory (geometric optics) from field equations; and Eikonal approximations. 4 cr.

## **842. DISCONTINUOUS CONTROL**

Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods that use the quantized nature of the information are also developed. Design methods for pulse-width modulation, optimum quantizers and limit cycle behavior of quantized systems are developed. (Also offered as E E 842.) 4 cr.

**844. NONLINEAR CONTROL SYSTEMS**  
 Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: M E 851. (Also offered as E E 844.) 4 cr.

**851. ADVANCED CONTROL SYSTEMS I**  
 State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Luenberger observers. Introduction to computer controlled systems (sampling, discrete state representation, hybrid systems); nonlinear analysis (Liapunov, Popov, describing function). Prereq: E E/M E 782. (Also offered as E E 851.) 3 cr.

### 852. ADVANCED CONTROL SYSTEMS II

Special topics in control theory: continuous and discrete systems; optimal control systems, including calculus of variations, maximum principle, dynamic programming, Weiner and Kalman filtering techniques, stochastic systems, adaptive control systems. Prereq: E E/M E 851. (Also offered as E E 852.) 3 cr.

### 855. ESTIMATION AND FILTERING

Stochastic systems course with application to control and communications. Topics include random variables, noise in linear systems, Bayesian and minimum variance estimation theory, optimal state estimators, Weiner and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: M E/E E 851, Math 735 or equivalent. (Also offered as E E 855). 3 cr.

### 861. PHYSICAL METALLURGY II

Thermodynamics of solid solutions and mixtures, kinetics of selected solid state reactions including precipitation and recrystallization, martensite transformations. 4 cr.

### 865. CONDUCTION PROPERTIES IN SOLIDS

Topics in metal and semiconductor physics. Quantum theory, electron energy states, scattering processes, band theory, electron and hole conduction, and the P-N junction. 4 cr.

### 882. MATHEMATICAL METHODS IN ENGINEERING SCIENCE II

Continuation of M E 781. Complex variable techniques, integral transform techniques for the solution of differential and partial differential equations, Green's functions. Weiner-Hopf techniques, variational techniques, stochastic problems with application to random vibration, statistical control theory, turbulence, heat conduction and fluctuation phenomena in solids, transport theory, gases, and liquids. Topics may vary from year to year. Prereq: M E 781. 4 cr.

### 883. TENSOR ANALYSIS AND DIFFERENTIAL GEOMETRY

Mathematical groundwork for applied group theory, transformation groups, affine groups and af-

fine geometry. Coordinate transformations and point transformations. Affinors, tensors, and their algebraic properties. Invariant differential operators. Lie derivative, holonomic and anholonomic coordinate systems. Curvature tensor, Bianchi identity, tensor densities. Green's theorem, Green's functions, potential functions, Pfaff's problem. 4 cr.

### 890 A-D, 891 A-D. SPECIAL TOPICS IN ENGINEERING

Course numbers refer to topics in A) Thermodynamics; B) Mechanics; C) Engineering Design; and D) Materials. Content of these courses may vary from year to year. 2-4 cr.

### 892. MECHANICAL ENGINEERING MASTER'S PROJECT

The student works with a faculty member during one or two semesters on a well-defined research and/or original design problem. A written report and seminar are presented. 4 cr.

### 895 A-D, 896 A-D. GRADUATE INDEPENDENT STUDY

Investigation of graduate-level problems or areas germane to mechanical engineering. 4 cr.

### 899. MASTER'S THESIS 6-10 cr.

## Microbiology (Micr)

**Chairperson:** Robert M. Zsigray

**PROFESSORS:** William R. Chesbro; Galen E. Jones

**ASSOCIATE PROFESSORS:** Richard P. Blakemore; Thomas G. Pistole; Robert M. Zsigray

**ASSISTANT PROFESSOR:** Florence E. Farber  
**GRADUATE PROGRAM COORDINATOR:** Richard P. Blakemore

Students admitted to graduate study in microbiology are expected to have had adequate preparation in the biological and physical sciences and in the basic courses in microbiology.

The candidate for the Master of Science degree will be required to complete a thesis. Candidates for the Doctor of Philosophy degree must teach at least one semester, or have had equivalent experience; must demonstrate to the doctoral committee a broad, basic knowledge of the field of microbiology; and must complete a dissertation embodying the results of original research in microbiology.

Departmental research activities emphasize bacterial host-parasite interactions, immunology, analysis of microbial structures, bacterial and bacteriophage genetics, virology, cell culture phenomena, public health aspects of microbiology and virology, bacterial physiology, and marine and soil microbiology.

### 701. TAXONOMY AND ECOLOGY

Isolation, identification, and classification of prokaryotic microorganisms by classical and newer techniques; analysis of the interplay between organisms and environment based on energy metabolism and use of this to deduce a natural classification; uses of taxonomic and ecological information. Prereq: gen micr; gen bchm. Lab. 4 cr.

**702. PATHOGENIC MICROBIOLOGY**

Morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Prereq: gen micr. Lab. 4 cr.

**705. IMMUNOLOGY AND SEROLOGY**

Examination of the immune response in vertebrates. Characterization of the major components of the immune system; study of host-defense mechanisms and immunopathology; use of serological techniques for identification and diagnosis. Prereq: Micr 702; permission. Lab. 4 cr.

**706. VIROLOGY**

Principles of animal, and in selected instances, plant and bacterial virology in relation to infection and disease. Emphasis on the molecular biology of viruses, viral replication, isolation, propagation, assay, pathogenesis, diagnosis, epidemiology and control. Virus-host interactions, especially the role of viruses in malignant transformation. Prereq: Micr 702; permission. Lab. 4 cr.

**707. MARINE MICROBIOLOGY**

Characterization of microorganisms in the sea including taxonomy, physiology, and ecology; sampling, enumeration, distribution; and effects of marine environment upon microbial populations. Prereq: gen micr; organic chemistry. Lab. 4 cr.

**708. MICROBIAL BIOGEOCHEMISTRY**

Geochemical processes influenced by biochemical processes catalyzed by marine and terrestrial microorganisms; transformations of carbon, nitrogen, and other elements. Petroleum microbiology, natural gas production, sulfur formation, ferro-manganese nodules, corrosion, and fossil microorganisms. Prereq: gen micr; organic chemistry. Lab. 4 cr.

**710. MICROBIAL CYTOLOGY AND ULTRASTRUCTURE**

Ultrastructure and function in prokaryotic cells; discussion of flagella, pili, walls, membranes, cytoplasmic inclusions, cell division, sporulation, and germination. Cytological features of structurally unique bacteria. Prereq: gen micr. 3 cr.

**711. TRANSMISSION ELECTRON MICROSCOPY**

Electron microscopic techniques for the study of microbial cytology; theory and use of the transmission electron microscope; sample preparation methods, photomicrography, and photographic darkroom techniques; interpretation of electron micrographs. Prereq: gen micr; Micr 710; permission. Lab. 4 cr.

**712. SOIL MICROBIOLOGY**

Microbial ecology of the soil environment; characteristics of major microbial groups in soil; factors affecting activity of soil microorganisms; their effects on the environment; and biological interactions which involve them. Prereq: gen micr. Lab. 4 cr.

**793. PROBLEMS IN MICROBIAL CYTOLOGY**

A) Research with Electron Microscopy; B) Teaching Practices in Electron Microscopy. Students may select sections for advanced study. May include reading, laboratory work, organized seminars, and conferences. Other sections may be offered in some semesters; consult with department office for future semester offerings. Prereq: permission. 1-4 cr.

**795, 796. PROBLEMS IN MICROBIOLOGY**

Prereq: permission. 1-8 cr.

**802. MICROBIAL PHYSIOLOGY**

Means by which microorganisms survive; nutritional, chemical, physical factors; metabolism and its regulation; generation of cell ultrastructure; ecological interactions. Prereq: gen micr; gen bchm. Lab. (Not offered every year.) 2 or 4 cr.

**804. MICROBIAL GENETICS**

Expression, regulation, recombination and transmission of genetic information in prokaryotic and eukaryotic microorganisms. Consideration of chromosomal and extrachromosomal inheritance. Prereq: gen micr; permission. Lab. 4 cr. (Not offered every year.)

**806. ADVANCED IMMUNOLOGY**

Basic concepts in immunology including immunorecognition, effector systems, immunogenetics, immunopathology, and comparative immunology. Prereq: gen immunol; gen bchm; permission. Lab. 4 cr. (Not offered every year.)

**851. CELL CULTURE**

Theory, principles fundamental to culture of cells in vitro. Introduction to techniques of preparation and maintenance of animal, plant, insect, fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prereq: gen micr; permission. Lab. (Also offered as AnSc 851.) 4 cr.

**893. ADVANCED PROBLEMS AND TECHNIQUES IN MICROBIAL CYTOLOGY**

A) Research with Electron Microscopy; B) Seminar in Microbial Cytology; C) Recent Developments in Electron Microscopy; D) Scanning Electron Microscopy; E) Freeze-Etching; F) Energy-dispersive X-ray Analysis; G) Photographic Techniques for Cytology; H) Electron Microscope Maintenance. Course sections for advanced work, individual or group seminar. May include reading, laboratory work, organized seminars, and conferences. Most sections not offered every year; consult with department office for future semester listings. Prereq: gen micr; electron microscopy; permission. 1-8 cr.

**897, 898. MICROBIOLOGY SEMINAR**

Reports, discussion, microbiological literature, and current developments in microbiology. Prereq: permission. 1 cr.

**899. MASTER'S THESIS**  
6-10 cr.

**999. DOCTORAL RESEARCH**

## **Music (Musi)**

**Chairperson:** Cleveland L. Howard

**PROFESSORS:** Keith Polk; John D. Wicks  
**ASSOCIATE PROFESSORS:** Ruth S. Edwards; Stanley D. Hettinger; Cleveland L. Howard; Mary H. Rasmussen; John E. Rogers; W. Niel Sir; Paul F. Verrette; Henry J. Wing, Jr.

The Department of Music offers programs leading to the degrees of Master of Arts in music and Master of Science in music education.

### **Master of Arts in Music**

The degree of Master of Arts in music, while designed basically for students interested in broadening their knowledge of the history of music in all of its dimensions, has proven consistently valuable to students who wish to augment strong backgrounds in performance and/or education with more specialized studies in theory, literature, and performance-practice. The following courses (or their approved equivalents) are required: Musi 855, 856, 857, 858, 891, and 893 or 894. Courses at the 700 level in music, or the 600, 700, and 800 level in other departments, may be elected with the approval of the student's adviser. It is recommended that more than two semesters be allowed for completion of the degree. The cultural advantages of the city of Boston, 90 minutes away, are a valuable adjunct to the program.

A B.A. degree in music or its equivalent from an accredited institution is required for admission to this program. A performance audition and a placement examination in theory, music history, and aural identification are normally required of all applicants and are taken in the semester preceding entrance into the graduate program. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the satisfaction of the department. A reading knowledge of both German and French is strongly recommended before entering the program; a German reading examination will be administered by the department. On recommendation of the graduate adviser, this requirement may be waived for students who do not plan further study beyond the M.A. degree. Completion of the program requires an oral exam and a written essay of substantive nature on a topic of the candidate's special interest.

### **Master of Science in Music Education**

The goal of the Master of Science in music education degree is to develop a broad knowledge at the graduate level in the fields of music education, performance, history, theory, and independent study. Each candidate will be required to complete one of the following: a professional paper; a field study in music education; a satisfactory recital appearance; a major composition, orchestration, or band arrangement; or the preparation and conducting of a major work in public performance for band, orchestra, or chorus. The following courses are required: Musi 855, 893 or 894; MuEd 796, 883 or 884. Also required are two courses in the Department of Education from courses such as the following: Educ 820, 827, 841, 853, 858, 861, 865, 883, 884, 886, and in special cases, 700, 701, and 705. Vocal or instrumental study at the 800 level

is required to a minimum of 4 credits. A maximum of 9 credits is allowed if the graduate recital option is elected. Sufficient electives must be taken to total 30 credits.

Admission to this program depends upon a bachelor's degree in music education or its equivalent from an accredited institution. A performance audition and a placement examination in theory, music history, and aural identification are normally required of all applicants and are taken in the semester preceding entrance into the graduate program. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the department's satisfaction.

### **History and Literature**

#### **701. MUSIC OF THE MEDIEVAL PERIOD**

Nature of the beginnings of polyphony. The preeminent influence of the church in the 13th century and the rising secular movement in the 14th. Music as a dominant force in the political and social life of the Middle Ages. 4 cr.

#### **703. MUSIC OF THE RENAISSANCE**

Works of the 15th- and 16th-century composers from Dunstable to Palestrina. 4 cr.

#### **705. MUSIC OF THE BAROQUE**

Music of Europe from de Rore to Bach. 4 cr.

#### **707. MUSIC OF THE CLASSICAL PERIOD**

Growth of musical styles and forms from early classicism through the high classicism of Haydn, Mozart, and the young Beethoven. 4 cr.

#### **709. MUSIC OF THE ROMANTIC PERIOD**

A survey of Romanticism in music from Beethoven's late period to the end of the 19th century. The works of Schubert, Berlioz, Schumann, Mendelssohn, Chopin, Wagner, Verdi, Brahms, Austrian symphonists, French pre-impressionists, and national styles in European music. 4 cr.

#### **711. MUSIC OF THE 20TH CENTURY**

Styles and techniques of composers from Debussy to the present. Special emphasis on tonal music before World War I; neoclassical trends; the emergence of atonality and serial techniques; antirationalist music; electronic music. 4 cr.

#### **721. THE LIFE AND WORKS OF BEETHOVEN**

Detailed study of Beethoven, his times, and his art as exemplified by his symphonies, piano music, chamber music, sacred music, and works for the stage. 4 cr.

#### **732. THE ART SONG**

History and literature of the solo song with piano accompaniment. Survey of national styles of the 19th and 20th centuries and deeper study of the central core of the art song—the German Lied. 4 cr.

#### **733. SURVEY OF OPERA**

History of the genre from Monteverdi to the present. Representative masterpieces by Handel, Moz-

art, Beethoven, Weber, Wagner, Verdi, Mussorgsky, Debussy, Berg, and others. 4 cr.

### **735. SURVEY OF PIANO LITERATURE**

Keyboard literature from the baroque to the present. Analysis, discussion, and illustration of works by Bach, Haydn, Mozart, Beethoven, the romantic composers, and contemporary writers. 4 cr.

### **795. SPECIAL STUDIES IN MUSIC**

A) J. S. Bach; B) Franz Schubert; C) Debussy and Ravel; D) The World of Jazz; E) The Iconography of Western-European Musical Instruments; F) 19th-Century French Music; G) Advanced Analysis; H) Advanced Study in Electronic Music; I) Composition through Computer-generated Sound; J) Woodwind Literature; K) Brass Literature; L) String Literature; M) Medieval Performance Practice; N) Renaissance Performance Practice; O) Baroque Performance Practice; P) Classical Performance Practice; Q) 19th-Century Performance Practice; R) 20th-Century Performance Practice; S) Woodwind Repair; T) String Repair; U) Advanced Jazz Improvisation; V) Advanced Piano Pedagogy; W) Advanced Accompanying; X) Advanced Conducting; Y) Independent Study. Prereq: permission. May be repeated for credit with permission. 1-4 cr.

### **855. INTRODUCTION TO BIBLIOGRAPHY**

An intensive survey of basic reference works, music periodicals, collected editions, series, treatises, books on musical instruments and performance practice, and the important monographs on major composers from Machaut to Schoenberg. A reading knowledge of German and French is very useful. 3 cr.

### **856. READINGS IN MUSIC HISTORY: ANTIQUITY TO 1600**

An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

### **857. READINGS IN MUSIC HISTORY: 1600-1820**

An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

### **858. READINGS IN MUSIC HISTORY: 1820 TO THE PRESENT**

An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

### **891, 892. RESEARCH SEMINAR**

Guidance in individual research projects. Prereq: permission. Variable cr.

### **895. INDEPENDENT STUDY IN THE HISTORY AND THEORY OF MUSIC**

Opportunity for especially qualified students to investigate, with guidance, specific areas of their scholarly concern. Prereq: permission. 1-4 cr.

### **Theory and Composition**

#### **771-772. COUNTERPOINT**

Contrapuntal techniques of tonal music. Melodic construction and dissonance treatment through work in species counterpoint and studies in harmonic elaboration and prolongation. Analysis of selected compositions emphasizes the connection between fundamental contrapuntal techniques and the voice-leading of composition. Prereq: music theory II or permission. 2 cr.

### **773. ADVANCED COUNTERPOINT**

Continuation of Musi 772. Prereq: Musi 772 or permission. 2 cr.

### **775-776. COMPOSITION**

Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prereq: music theory II or permission. 3 cr.

### **777. ADVANCED COMPOSITION**

Continuation of Musi 776. Individual compositional projects. Prereq: Musi 776 and permission. May be repeated for credit. 3 cr.

### **779. ORCHESTRATION**

Characteristics of band and orchestral instruments both individually and in small (homogeneous) and large (mixed) groupings. Students study scores, write arrangements, and have arrangements performed if at all possible. Some aspects of vocal writing. Prereq: music theory II or permission. 4 cr.

### **781. FORM AND ANALYSIS**

Formal and textural elements; concepts and examples. Thorough analysis of smaller and larger masterworks from the standpoint of harmony, counterpoint, structural line, and formal articulation. Prereq: music theory II or permission. 4 cr.

### **785. ELECTRONIC SOUND SYNTHESIS**

Part I: "traditional" or "analog" electronic sound synthesis; work with the Buchla Synthesizer in the electronic music studio. Part II: 1) elementary programming in FORTRAN; 2) the logic of computer sound syntheses; and 3) programming in MUSIC 4BF. Students will have the opportunity to run programs on a DEC KL10 computer equipped with 4-channel digital-to-analog and analog-to-digital converters. Part III: completion of a major independent study project in electronic music. Prereq: permission. 4 cr.

### **795. SPECIAL STUDIES IN MUSIC**

Refer to *History and Literature* section.

### **893. THEORY SEMINAR**

Through reading, analysis, and composition, the student is acquainted with music theory from the Middle Ages to Monteverdi. Prereq: permission. 3 cr.

### **894. THEORY SEMINAR**

Theory and practice from the Baroque to contemporary music. Performance practice in the Baroque and later periods. Score analysis. Prereq: permission. 3 cr.

### **895. INDEPENDENT STUDY IN THE HISTORY AND THEORY OF MUSIC**

Refer to *History and Literature* section.

### **Performance**

### **795. SPECIAL STUDIES IN MUSIC**

Refer to *History and Literature* section.

### **841-851. APPLIED MUSIC FOR GRADUATE CREDIT**

The following courses offer further development of technique, music interpretation, and repertory on the various instruments. Emphasis may also be

directed toward the functional use of the instrument in the school room. Private lessons are based on a half-hour of individual instruction per week. One semester-hour credit may be earned with one lesson per week; 2 or 4 semester hours of credit may be earned with two lessons per week. Five one-hour practice periods are expected for each credit of private study. The special fee for a one-half hour lesson per week is \$35 per semester in addition to normal tuition charges. The fee includes the use of a practice room for the required preparation. Prereq: student must exhibit sufficient proficiency to warrant graduate study and must have permission of the department chairperson and the student's graduate adviser. Audition required. A student may register for credit in the same courses in successive semesters with the approval of the major adviser. Music staff. 1, 2 or 4 cr.

#### **841. GRADUATE VOICE**

#### **842. GRADUATE PIANO**

#### **843. GRADUATE HARPSICHORD**

#### **844. GRADUATE ORGAN**

#### **845. GRADUATE VIOLIN, VIOLA**

#### **846. GRADUATE VIOLONCELLO, STRING BASS**

#### **847. GRADUATE WOODWIND**

#### **848. GRADUATE BRASS**

#### **849. GRADUATE PERCUSSION**

#### **850. GRADUATE HARP**

#### **851. GRADUATE EARLY WIND INSTRUMENTS**

### **Music Education (MuEd)**

#### **741-742. TECHNIQUES AND METHODS IN CHORAL MUSIC**

Problems in the organization and performance of high school, college, and community choruses. Techniques of choral conducting and rehearsal, repertory, and materials. 2 cr.

#### **743. MATERIALS AND METHODS IN PIANO MUSIC**

Gives potential piano teachers a coherent but flexible approach to the instruction of students of different ages and levels of talent through evaluation of methods and materials and discussion of the role of the private teacher. 2 cr.

#### **745-746. TECHNIQUES AND METHODS IN STRING INSTRUMENTS**

Class and individual instruction. Four-hour practice per week required. Intensive training on the violin, viola, cello, and double bass enables participants to perform in string ensembles. Classroom procedures, establishment of string programs, and evaluation of available methods materials. 2 cr.

#### **747-748. TECHNIQUES AND METHODS IN WOODWIND INSTRUMENTS**

Basic fundamentals of performance, class instruction, associated acoustical problems, and study of woodwind literature. First semester: clarinet, flute, and saxophone. Second semester: double-reed instruments. 2 cr.

#### **749. TECHNIQUES AND METHODS IN BRASS INSTRUMENTS**

Basic course in embouchure formation, tone, tonguing, fingering, flexibility, accuracy, and range development as applied to the trumpet or baritone horn, French horn, and trombone; methods, studies, solos, and ensembles most likely to be useful with grade school, junior high school, and high school players of brass instruments. 2 cr.

#### **751. TECHNIQUES AND METHODS IN PERCUSSION INSTRUMENTS**

Basic performance skills on snare drum, timpani, mallet instruments, and other percussion instruments used in bands and orchestras. Materials and methods of instruction. 2 cr.

#### **785. MUSIC FOR THE ELEMENTARY CLASSROOM TEACHER**

Designed for the nonspecialist. Correlation and integration of music in the school curriculum, and basic skills and techniques necessary. 4 cr.

#### **787-788. THE TEACHING OF ELEMENTARY AND MIDDLE SCHOOL MUSIC**

Aims, scope, and organization of materials and activities in elementary and middle schools. Modern trends in educational philosophy; development of the child's voice; demonstration of materials and methods for the various grades. Observation and teaching in schools. 2 cr.

#### **791-792. THE TEACHING OF SECONDARY SCHOOL MUSIC**

Educational principles applied to music teaching and learning; curriculum organization for junior and senior high school. Adolescent voice, voice classification, selection of vocal and instrumental materials, and building unified concert programs. Problems of administration; management; relationship of the teacher to school and community. Observation of secondary school music programs. 2 cr.

#### **795. SPECIAL STUDIES IN MUSIC EDUCATION**

Allows upper-level students to explore individually or in groups areas related to their specific professional interests. Prereq: permission. 1-4 cr.

#### **796. ORGANIZATION AND ADMINISTRATION OF SCHOOL MUSIC GROUPS**

Problems of organizing and administering school orchestras, bands, glee clubs, choruses, and small ensembles; objectives, motivation, schedule, discipline, equipment, programs, finances, rehearsal techniques, contests and festivals, materials, personnel selection, and grades. 4 cr.

#### **883. INSTRUMENTAL LITERATURE AND ITS PERFORMANCE**

Exploration of representative solo and ensemble music for string, wind, and percussion instru-

ments. Typical literature from each period of music is studied. As much as is possible, live performance is included; recordings are used as required. Detailed attention given to interpretation. Project required. 3 cr.

#### **884. CHORAL LITERATURE AND ITS PERFORMANCE**

Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students will have the opportunity to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college repertoires. 3 cr.

#### **895. SPECIAL PROJECTS IN MUSIC EDUCATION**

Independent study, investigation, or research in music education. Creative projects may be included. Prereq: permission. 1-4 cr.

### **Occupational Education (OcEd)**

**Chairperson:** William H. Annis

**PROFESSORS:** William H. Annis; Maynard C. Heckel

**ASSOCIATE PROFESSOR:** Lewis Roberts, Jr.

**ASSISTANT PROFESSOR:** Gregory D. Gill

The Master of Occupational Education degree is designed for teachers and administrators of occupational education, county Cooperative Extension Service personnel, and others in adult education. Applicants must submit scores achieved on either the Graduate Record Examination, aptitude section, or the Miller Analogies Test. All students are required to complete Occupational Education 785 and 786. The remainder of the 30+ credits required to complete the degree program will be selected in consultation with the student and advisers according to the student's career plans, needs and goals. Students may elect the thesis plan. Candidates completing a thesis will be required to complete an oral examination. Students following the nonthesis plan will be required to complete written and oral examinations plus a professional paper. For further information, contact Chairperson William H. Annis.

#### **700. WORKSHOPS IN OCCUPATIONAL EDUCATION**

Modularized instruction for in-service education of teachers of vocational education and others in occupational education. May be repeated up to 8 credits. 1-2 cr.

#### **750. SHOP ORGANIZATION AND CONTROL METHODS**

Purposes: 1) to examine all facilities of vocational programs in New Hampshire to insure safety, quality instruction, and adequate usage of space; 2) to examine the role of the vocational instruction relating to liability, maintenance of equipment, planning for improvements in facilities, and planning for new facilities. 4 cr.

#### **783. CONDUCTING AND SUPERVISING ADULT EDUCATION PROGRAMS**

Analysis of formal and informal adult education

programs; development of strategies of program planning, instruction, evaluation, and supervision. 4 cr.

#### **784. THE COMMUNITY-JUNIOR AND VOCATIONAL-TECHNICAL COLLEGES**

Rise and development of community-junior colleges and two-year vocational-technical colleges in American education; their history, potential, philosophy, and functions. 4 cr.

#### **785. ADVANCED METHODS AND MATERIALS OF INSTRUCTION**

Organization and delivery of performance-based instruction. Provides opportunities for exploration in instructional planning, execution, evaluation, management, and guidance. Open to teachers of vocational-technical education and others by permission. Required of master's degree candidates. 4 cr.

#### **786. CONCEPTS OF OCCUPATIONAL EDUCATION**

Development of vocational-technical education in the U.S.; socio-economic influences responsible for its establishment. Federal and state requirements for secondary and post-secondary schools. Coordination of programs with general education and other vocational fields. Required of master's degree candidates. 4 cr.

#### **787. ADMINISTRATION AND SUPERVISION OF VOCATIONAL EDUCATION**

Students identify and develop competencies required of vocational administrators, using a vocational administrator task analysis, which includes fair hiring and firing practices, staff development, long-range planning, federal administration for vocational programs, and evaluation of program effectiveness. Philosophy of, and federal regulations governing, vocational education. 4 cr.

#### **791. PLANNING FOR TEACHING**

Organization of materials of instruction to meet group and individual needs. Techniques of instruction, planning for teaching, function of consulting committees, working with youth groups, program evaluation. Course scheduled concurrently with Educ 694. Prereq: microteaching. 4 cr.

#### **796. INVESTIGATIONS IN OCCUPATIONAL EDUCATION**

A) Career Education; B) Secondary Education; C) Post-Secondary Education; D) Adult Education; E) Extension Education; F) Exemplary Programs; G) Cooperative Education Programs; H) Disadvantaged and Handicapped Education Programs. Student-selected problems in one of the areas listed. Elective after consultation with the instructor. Hours to be arranged. May be repeated. 2-4 cr.

#### **798. OCCUPATIONAL EDUCATION SEMINAR**

Discussion of current issues, problems, and research and development in OcEd. Students, faculty, and other personnel serve as discussion leaders. Required of OcEd majors, and graduate students. 0-2 cr. (Fall semester only.)

**804. PROGRAM PLANNING IN OCCUPATIONAL EDUCATION**

A systematic approach to the development of course materials for occupational education. Topics included are: occupational analysis, establishing performance objectives, selection of content, development of supplemental material, and evaluation. Prereq: a course in teaching methods or permission. 4 cr.

**805. THE DEVELOPMENT OF COOPERATIVE EDUCATION PROGRAMS IN OCCUPATIONAL EDUCATION**

Topics included are: relationship with community; student selection and development of individual programs; the supervision and evaluation of these programs. 4 cr.

**806. DEVELOPING VOCATIONAL PROGRAMS FOR SPECIAL NEEDS LEARNERS**

Designed for teachers and administrators in vocational education who are working with or preparing to work with disadvantaged and/or handicapped individuals. Focus on issues associated with planning, developing, implementing, and evaluating vocational programs for special needs learners. 4 cr.

**807. ORGANIZATION AND SUPERVISION OF YOUTH ORGANIZATIONS**

The purposes and organization of youth organizations, establishing the local organization, planning and developing a program of work, ways and means of improving the local organization, and methods of evaluation. 4 cr.

**809. COMMUNITY ORGANIZATION AND PUBLIC RELATIONS**

The composition, purposes, and objectives of the various social and economic organizations operating in local communities. The importance of their membership to the general welfare of the area and the development of a public relations program. 4 cr.

**811. INTERNSHIP IN OCCUPATIONAL EDUCATION**

Internship in a field of occupational education either in methodology of teaching or technical subject matter. Students may elect internship only after completing the qualifying examinations for the master's degree, with permission of their major adviser. May be repeated up to 8 cr. 0-8 cr.

**812. INTRODUCTION TO RESEARCH**

The course is designed to develop a knowledge and understanding that will contribute to the effective use of research in teaching and administering occupational education. The research process will be examined in terms of selection and formulation of research problems, design, techniques of data collection, analysis, and interrelation of data and reporting. 4 cr.

**895. INDEPENDENT STUDY IN OCCUPATIONAL EDUCATION**

Individual study problems in various phases of occupational education. Prereq: permission. May be repeated. 2-6 cr.

**899. MASTER'S THESIS**  
6-10 cr.**Physical Education (PhEd)**

**Chairperson:** D. Allan Waterfield

**ASSOCIATE PROFESSORS:** Katherine Amsden; Gavin H. Carter; Phyllis A. Hoff; Robert Kertzer; D. Allan Waterfield; Robert E. Wear; Walter E. Weiland

**ASSISTANT PROFESSORS:** Lori A. Alexander; D. Michael McKeough

**GRADUATE PROGRAM COORDINATOR:**  
Katherine Amsden

The Department of Physical Education offers a graduate program leading to the Master of Science degree in Physical Education, with the following areas of concentration: exercise specialist, motor behavior, and teaching/coaching. Admission is based on undergraduate preparation, academic record, Graduate Record Examination aptitude test scores, and letters of recommendation. Applicants must be above-average students and show adequate preparation in the basic support courses of the emphasis area of intended study. Applicants who have not met specific course prerequisites should expect to take additional undergraduate work without receiving graduate credit.

Students may satisfy program requirements through the thesis or nonthesis program plans. All degree candidates will be required to take PhEd 801, one of the following statistics courses (INER 701, Math 636, Psyc 601, or Soc 602), and two courses from the selected area of concentration. Concentration courses: exercise specialist (PhEd 720, 731, 732, 895); motor behavior (PhEd 740, 775, 780, 850); teaching/coaching (PhEd 730, 731, 750, 780). All remaining course work may be taken within the Department of Physical Education; however, approval may be granted to take relevant courses outside the department.

**Thesis Plan:** A minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) is required in the thesis plan, plus an oral defense of the thesis.

**Nonthesis Plan:** A minimum of 32 approved graduate credits is required in the nonthesis plan. Four credits of PhEd 895 (Advanced Studies) are required. A student may take PhEd 895 only after completing at least three approved graduate courses, including PhEd 801.

The program is sufficiently flexible to meet professional interests and special abilities. With the help of the graduate adviser in physical education, the student's program will be individually planned.

**702. ADVANCED ATHLETIC TRAINING**

Assessment, rehabilitative treatment, preventive strapping, and protective equipment used in athletic training. Administration of a training room facility. Prereq: basic athl train. Lab. 4 cr.

**703. LABORATORY PRACTICE IN ATHLETIC TRAINING**

150 hours of experience in UNH athletic training room under N.A.T.A. certified trainer. Prereq: basic athl train. (Only two credits may be applied toward master's degree requirement.) 2 cr.

**710. UNDERWATER RESEARCH METHODS**

Lecture, open water, and pool instruction in underwater research techniques and hyperbaric physiology lab. Prereq: basic certification and permission. Fee. 4 cr.

**720. INTERPRETATION AND ASSESSMENT OF PHYSICAL FITNESS**

Planning and implementation of programs of conditioning and fitness in the general program of education in the school. Personal fitness; components of physical fitness and conditioning; current tests; rehabilitation of individuals of all ages, particularly in college and adult programs. Prereq: physiol of exercise or equivalent. 4 cr.

**730. CURRICULUM PLANNING IN PHYSICAL EDUCATION**

Criteria and factors involved in planning and construction of school programs. 4 cr.

**731. CONDITIONING FOR MAXIMUM PERFORMANCE**

Anatomical and physiological factors related to maximum physical performance. Evaluation of present programs of training. Prereq: physiology of exercise or equivalent. 4 cr.

**732. ELECTROCARDIOGRAPHY AND GRADED EXERCISE TESTING**

Introduction to the electrocardiogram, with specific application to graded exercise testing. Required for exercise specialist: two hours of lecture, two hours of lab. Prereq: exercise laboratory techniques. 3 cr.

**740. PERCEPTUAL MOTOR DYSFUNCTION**

Theoretical rationale and clinical perceptual-motor training programs of Ayres, Kephart, Cratty, Barsch, and Getman, as they relate to sensory-motor integration and the remediation of learning disabilities. Prereq: PhEd 775, or permission. 4 cr.

**750. ANALYZING TEACHING IN PHYSICAL EDUCATION**

Examination of teaching practices, theories, and research implications. Varied approaches to the study and improvement of teaching, including analysis of films and tapes. Prereq: theory of teach phys ed in sec school, theory of teach phys ed in elem school, or permission. 4 cr.

**775. PERCEPTUAL MOTOR LEARNING**

Variables affecting the learning and performance of skilled activity; ability and motivational characteristics of the learner; processes for skill acquisition. Prereq: intro to psych. Lab. 4 cr.

**780. PSYCHOLOGICAL FACTORS IN SPORT**

Factors of outstanding athletic achievement; psychological variables in competition; the actions and interactions of sport, spectator, and athlete. Prereq: intro to psych; /or PhEd 775. 4 cr.

**791. HISTORY OF PHYSICAL EDUCATION**

From ancient Egypt to modern times. Influences of Greece, Rome, the Renaissance and Reformation periods, and modern European nationalism. Analysis of events and the beliefs of leaders in the development of systems of physical education. 4 cr.

**795. SPECIAL TOPICS**

New or specialized courses not normally covered in regular course offerings. Prereq: permission. May be repeated up to 8 cr. 2-4 cr.

**801. ANALYSIS OF PROFESSIONAL LITERATURE**

Critical interpretation of professional literature. 4 cr.

**841. SOCIAL DIMENSIONS OF SPORT**

Sport viewed from a social-cultural, action-system frame of reference and studied on the level of cultural values and their related social structures. Prereq: intro soc or equivalent. 4 cr.

**850. SEMINAR IN MOTOR LEARNING**

Theoretical models of skill acquisition, motor skill taxonomies, and current issues in motor-learning research. Prereq: PhEd 775 or equivalent. 4 cr.

**895. ADVANCED STUDIES**

Independent study problems. Prereq: permission of graduate adviser. May be repeated up to 8 cr. 2-4 cr.

**899. MASTER'S THESIS**

6 cr.

**Physics (Phys)**

**Chairperson:** Roger L. Arnoldy

**PROFESSORS:** Roger L. Arnoldy; L. Christian Balling; Edward L. Chupp; John F. Dawson; Lennard A. Fisk, Jr.; Jochen Heisenberg; Robert E. Houston, Jr.; Richard L. Kaufmann; Robert H. Lambert; John A. Lockwood; Lyman Mower; John E. Mulhern, Jr.; Harvey K. Shepard; William R. Webber; John J. Wright

**ASSOCIATE PROFESSORS:** Barry J. Harrington; Robert E. Simpson

**RESEARCH ASSOCIATE PROFESSORS:** John R. Calarco; Joseph V. Hollweg

**GRADUATE PROGRAM COORDINATOR:** Richard L. Kaufmann

The physics department offers courses leading to three graduate degrees: Master of Science for Teachers; Master of Science and Doctor of Philosophy in physics. Graduate students entering the Master of Science and Doctor of Philosophy programs are expected to demonstrate a proficiency in undergraduate work equivalent to that in the senior year at the University of New Hampshire.

***Master of Science for Teachers***

The degree of Master of Science for Teachers is offered for candidates who satisfy the general admission requirements (see page 12) or who hold secondary school teacher certification in physics or in general physical science. The courses leading to this degree will normally be chosen so as to improve candidates' ability to teach physics or general physical science at the secondary school level. These courses should total at least 30 semester hours and should be chosen in consultation with the graduate adviser in physics.

M.S.T. students are not required to take the qualifying examination. Teaching experience is required for this degree. Persons interested in this degree should confer with the graduate adviser.

## **Master of Science Degree**

For admission to graduate study leading to a Master of Science degree, students should have completed 24 to 30 semester hours in physics, or physics and closely allied fields. The courses required for the Master of Science in physics degree include Phys 831, 833 (or 834), 839, 841, and 843. Candidates may select one of the following plans:

1) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.

2) Complete 24 semester hours of courses chosen in consultation with the graduate adviser, complete a thesis representing the equivalent of six semester hours' work, and pass an oral examination on the thesis.

## **Doctor of Philosophy Degree**

For admission to graduate study leading to a Doctor of Philosophy degree, students should satisfy the same general requirements as for a Master of Science degree. Admission to candidacy for the degree is primarily based upon demonstrated ability in formal coursework; experience in teaching, equivalent to at least half-time for one year; and passing a written qualifying examination. This examination is normally taken during the second year. Exceptions to the timing are possible only by petition. Students are allowed a total of two attempts to achieve candidacy. Finally, upon completion of a thesis, doctoral candidates will take an oral examination based upon the area of their research.

The courses required for a Doctor of Philosophy degree in physics are: 1) 831-832, 833 (or 834), 835, 839, 841-842, 843-844; and 2) any additional five full courses at the 800 level, excluding 889, 890, 897, 898, 899, and 999. (For students doing Ph.D. research in astrophysics or space physics, one of these five courses must be 850 or 852.)

## **Interdisciplinary Research**

The department encourages research in areas related to physics or applied physics. Should students desire to do research in a field related to physics, special provisions may be made. A cooperative program with the Department of Electrical and Computer Engineering is available to master's students in physics. Contact the department chairperson or graduate adviser for details.

### **701-702. INTRODUCTION TO**

### **QUANTUM MECHANICS I AND II**

Modern physics, nonrelativistic Schroedinger equation, the hydrogen atom, applications to atomic and molecular structure. Prereq: diff eqns; multidim calculus; /or permission. Intro mathematical physics course desirable. 4 cr.

### **703-704. ELECTRICITY AND MAGNETISM I AND II**

Foundation of electromagnetic theory; electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents, Maxwell's field theory. Prereq: diff eqns; multidim calculus; /or permission. Intro mathematical physics course desirable. 4 cr.

### **710. INTRODUCTION TO MODERN COSMOLOGY**

Review of the sun, stars, Milky Way, external galaxies, and expansion of the universe. Recent discoveries of radio galaxies, quasi-stellar objects, cosmic black-body radiation, X-rays, and gamma rays precede a discussion of Newtonian and general relativistic cosmological models, steady-state/big-bang theories, and matter-antimatter models. Prereq: phys mechanics; diff eqns; /or permission. 4 cr.

### **713, 714. SPECIAL TOPICS I AND II**

Any selected topics not covered sufficiently in a general course may be studied. 4 cr.

### **718. INTRODUCTION TO SOLID STATE PHYSICS**

Theory underlying the behavior of solids. Transport theory and the interaction of radiation and matter. Operation of semiconducting and superconducting devices and lasers. Prereq: physical mechanics, intro quantum mechanics; diff eqns, multidim calculus. 4 cr. (Offered with sufficient demand.)

### **795, 796. INDEPENDENT STUDY**

Individual project under direction of a faculty adviser. Prereq: department permission. 1-8 cr.

### **831-832. MATHEMATICAL PHYSICS**

Complex variables, differential equations, asymptotic methods, integral transform, special functions, linear vector spaces and matrices, Green's functions, and additional topics selected from integral equations, variational methods, numerical methods, tensor analysis and group theory. 3 cr.

### **833, 834. EXPERIMENTAL PHYSICS I AND II**

Modern research techniques, including discussion and laboratory exercises in electromagnetism, nuclear, and atomic phenomena. Prereq: passing an electronics proficiency test or basic experimental physics I. 3 cr.

### **835. STATISTICAL PHYSICS I**

A review of thermodynamics and kinetic theory, followed by an introduction to classical and quantum statistical mechanics. Microcanonical, canonical, and grand canonical ensembles; ideal Fermi and Bose gases. Prereq: Phys 831; Phys 843; /or permission. 3 cr.

### **836. STATISTICAL PHYSICS II**

Basic formulation and application of statistical mechanics to selected physical problems. Prereq: Phys 844. (Offered on request.) 3 cr.

### **839. THEORETICAL MECHANICS**

Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies, with particular attention to those topics that serve as background for the study of modern physical theories. 3 cr.

### **841-842. ELECTROMAGNETIC THEORY**

The formulation and detailed application of electromagnetic theory to physical problems. Prereq: permission. 3 cr.

### **843-844. QUANTUM MECHANICS**

Wave mechanical and Dirac formulations of non-relativistic quantum mechanics. Prereq: permission. 3 cr.

**850. PLASMA PHYSICS I**

Topics to be discussed will be selected from the following: magnetohydrodynamics and plasma flow, waves, shocks and discontinuities, instabilities, and adiabatic motion of charged particles. 3 cr. (Not offered every year.)

**852. PLASMA PHYSICS II**

Topics to be discussed will be selected from the following: kinetic theory of plasmas, plasma waves, instabilities, and nonlinear plasma phenomena. Prereq: Phys 835; /or permission. 3 cr. (Offered on request.)

**853. SOLAR MAGNETOHYDRODYNAMICS**

Introduction to solar physics, with emphasis on gas dynamics and magnetic fields. Interior structure, the theory of convection, wave motions in the presence of magnetism and gravity, coronal heating theories, steady and nonsteady flows, dynamo theory, and the theory of solar flares and other transient phenomena. Salient observational data will be reviewed. Prereq: permission. 3 cr. (Not offered every year.)

**861-862. ADVANCED QUANTUM MECHANICS**

Relativistic wave equations, propagator theory and Feynman diagrams, quantum theory of radiation, second quantization, introduction to quantum field theory and related topics. Prereq: Phys 839; Phys 844. 3 cr. (Not offered every year.)

**863-864. NUCLEAR PHYSICS**

Introduction to nuclear processes including nuclear forces, nuclear structure and models, static properties, beta and gamma emission, and nuclear reactions. Selected topics in experimental methods. Prereq: Phys 844. 3 cr. (Not offered every year.)

**865-866. SOLID STATE PHYSICS**

Development of quantum mechanical theory of solids, transport phenomena, etc. Prereq: Phys 843; Phys 835. 3 cr. (Not offered every year.)

**887. INTRODUCTION TO SPACE SCIENCE I**

Topics will be selected from the following: ionospheric physics; magnetospheric physics; interplanetary physics; solar physics; cosmic ray physics; radio, x-ray, and gamma-ray astronomy; motion, transport, energy loss, origin, and acceleration of charged particles in the magnetosphere; interplanetary medium, and galaxy; cosmological problems. 3 cr. (Not offered every year.)

**888. INTRODUCTION TO SPACE SCIENCE II**

Extended investigation of one or more of the topics introduced in Phys 887. Offered on request. 3 cr.

**889, 890. SPACE PHYSICS SEMINAR**

Lectures and discussions of current research in the physics of fields and particles in space. 1-3 cr.

**891, 892. PROBLEMS IN THEORETICAL PHYSICS**

May be repeated to six credits. 1-3 cr. (Offered on request.)

**893, 894. PROBLEMS IN EXPERIMENTAL PHYSICS**

May be repeated to six credits. 1-3 cr. (Offered on request.)

**895, 896. SPECIAL TOPICS**

Any special fields of study not covered by the above courses may be included. Topic choices in previous years: astrophysics; elementary particles; lasers/masers; many-body theory; general relativity and cosmology; group theory; atomic physics; quantum theory of light. May be taken more than once. 1-3 cr.

**897, 898. COLLOQUIUM**

Required of all graduate students. Topics to be selected. 0 cr.

**899. MASTER'S THESIS**

6 cr.

**999. DOCTORAL RESEARCH**

**Plant Science (PLSc)**

**Chairperson:** Owen M. Rogers

**PROFESSORS:** George O. Estes; Kurt C. Feltner; J. Brent Loy; Lincoln C. Peirce; Owen M. Rogers; Douglas G. Routley

**ASSOCIATE PROFESSORS:** Yun-Tzu Kiang; David W. Koch; James R. Mitchell; James E. Pollard; Jerry A. Warren; Otho S. Wells

**ASSISTANT PROFESSOR:** John M. Roberts

**ADJUNCT ASSISTANT PROFESSOR:** Merrill C. Hoyle

The graduate research program in plant science is concerned with solving basic and applied problems associated with growth of crop plants and their response to the environment. Facilities include laboratories, greenhouses, growth chambers, and two experimental farms.

The program emphasizes two principal disciplines: 1) breeding and genetics; and 2) physiology and biochemistry. Research and teaching in plant genetics, cytogenetics, and plant breeding are major strengths complemented by University programs in genetics and statistics. A strong research and teaching program is also available in plant physiology, including advanced courses in plant nutrition, metabolism, and growth and development.

Undergraduates should obtain adequate background in the biological and physical sciences, including botany and chemistry. Students lacking these requirements may be admitted on condition that certain courses be completed without graduate credit. The aptitude section of the Graduate Record Examination is required for application.

Candidates for the Master of Science degree will be required to prepare a thesis and to pass an oral examination. Candidates for the Ph.D. degree must take a written and/or oral qualifying examination and a final oral examination on the dissertation, in which the student must demonstrate ability to do original research in the area of specialization. Supervised teaching or its equivalent is required for each master's and doctoral student.

**Advanced Plant Physiology****708. PLANT NUTRITION**

Nutritional aspects of higher plants; uptake and assimilation, metabolic roles and growth response. Fertilizers: sources, manufacture, application, and energy dependence. Prereq: chemistry. Lab. 4 cr. (Not offered every year.)

**762. PLANT METABOLISM**

Function, occurrence, synthesis and degradation of plant constituents; respiration and photosynthesis; metabolism of nitrogenous and aromatic compounds; biochemical mechanisms in seed dormancy, fruit ripening, and disease resistance. Prereq: general biochemistry or Bchm 751. 2 cr. (Not offered every year.)

**803, 804. TOPICS IN DEVELOPMENTAL PLANT PHYSIOLOGY**

A) Fungal Physiology; B) Photosynthesis I; C) Photosynthesis II; D) Nitrogen Fixation; E) Reproductive Physiology of Plants; F) Photomorphogenesis; G) Plant Hormones; H) Water and Solute Translocation; I) Stress Physiology; J) Genetic Control of Plant Development; K) Regulation of Gene Expression; L) Metabolic Control Mechanisms in Plants. A series of seven-week, 2-credit, in-depth modules; two modules per semester (may vary; consult *Time and Room Schedule*). Consult PISc or Bot departments for future semester offerings. Prereq: permission. PISc and Bot staff. 2-26 cr.

**Advanced Genetics (See Genetics Program)****705. POPULATION GENETICS**

Population growth and regulation; genetic variation; factors affecting gene frequency; ecological genetics. Prereq: prin of genetics or permission. 4 cr. (Offered fall 1982.)

**740. EVOLUTIONARY BIOLOGY**

Origin of life; sources of genetic variation; population structure, mechanisms of evolution; molecular evolution; ecological adaptation in animals, plants, and man; community structure and evolution. Prereq: prin of gen or permission. 4 cr. (Not offered every year.)

**773. METHODS AND THEORY OF PLANT BREEDING**

Plant breeding systems for qualitative and quantitative plant improvement. Prereq: prin of genetics; appl statistics; /or permission. 3 cr. (Not offered every year.)

**801. THE RESEARCH PROCESS**

For first-year M.S. and Ph.D. program students in biological sciences. Philosophy, logic, ethics in science; techniques of organization and design of research and of data presentation. 2 cr. Cr/F.

**802. DESIGN OF EXPERIMENTS**

The philosophy of experimental design and how it relates to standard statistical designs. Topics include the roles of replication and randomization, factorially arranged treatments, Latin squares, incomplete nonfactorial designs, fractional replications and confounding, and crossover designs. Prereq: INER 711; digital computer systems; /or permission. Mr. Warren. 4 cr. (Not offered every year.)

**851. PLANT GENETICS**

Euploidy, aneuploidy, cytoplasmic inheritance, somatic cell genetics, and genetics of disease resistance. Prereq: intro genetics. 3 cr. (Not offered every year.)

**853. CYTOGENETICS**

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cytogenetic analysis. Prereq: genetics; cytology. 3 cr. (Not offered every year.)

**General Offerings and Independent Studies****711. STATISTICAL METHODS II**

Intermediate course; basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangement of treatments, multiple regression, and covariance. Computer programs used in analyzing data. Examples from environmental sciences. Prereq: applied statistics I or equivalent. Mr. Barrett, Mr. Warren. 4 cr.

**720. LABORATORY TECHNIQUES IN PLANT SCIENCES**

Use of laboratory instruments and techniques including extraction procedures, spectrometry, fluorometry, electrophoresis, chromatography, atomic absorption spectrometer, measurement of respiration and photosynthesis, photography, use of microscopes, and use of instruments for monitoring the environment. Prereq: chemistry (three semesters) or permission. 2 cr. Cr/F.

**750. TOPICS IN AGRICULTURAL APPLICATIONS OF STATISTICS AND COMPUTING**

Two-credit, seven-week modules offered in the middle of the spring semester. A) Current Application of Computers in Agriculture; B) Development of Computer Applications in Agriculture; C) Simulation of Crop Development; D) Agricultural Systems; E) Techniques for Field Experiments. Consult department for current offering. Prereq: permission. Mr. Warren. 2-10 cr.

**776. RADIOISOTOPE TECHNIQUES FOR LIFE SCIENCES**

Application of radioisotopes to biological systems; characteristics, detection, measurement, and tissue distribution of radioisotopes. Prereq: chemistry. Lab. 4 cr.

**795, 796. ADVANCED TOPICS IN PLANT SCIENCE**

A) Physiology; B) Genetics; C) Plant Utilization. Independent research, study, or group discussion. Prereq: permission. Staff. 2 or 4 cr.

**877. SUPERVISED TEACHING FOR GRADUATE STUDENTS**

Planning and presenting classroom and laboratory material. Biweekly seminars discuss teaching technique and problems. One credit or its equivalent required of each plant science master's and Ph.D. candidate. Plant science graduate students only. Prereq: permission. 1 cr. Cr/F.

**895-896. RESEARCH IN PLANT SCIENCE**

Advanced investigations in a research subject, exclusive of thesis. 1-4 cr.

**897-898. GRADUATE SEMINAR**

Library research and discussion of current topics of plant science. Required of all graduate students majoring in plant science. 1 cr.

**899. MASTER'S THESIS**

A thesis requiring study in depth of a phase in plant science. Required of all master's candidates in plant science. 6-10 cr.

**999. DOCTORAL RESEARCH**

Dissertation reflecting independent research in a phase of plant science is required. Credit received upon completion.

## Political Science (Polt)

**Chairperson:** David L. Larson

**PROFESSORS:** Robert B. Dishman; Bernard K. Gordon; George K. Romoser

**ASSOCIATE PROFESSORS:** Warren R. Brown; Robert E. Craig; John R. Kayser; David L. Larson; David W. Moore; Lawrence W. O'Connell; B. Thomas Trout; Susan O. White

**ASSISTANT PROFESSOR:** Clifford J. Wirth

Candidates for admission to graduate study in the Department of Political Science normally are expected to have majored either in political science or a field closely related, and to have achieved an undergraduate academic record of some distinction. In unusual and exceptional cases and where undergraduate preparation has been insufficient, candidates may be admitted provided that they follow without credit a program of study approved by the chairperson. In all cases the Graduate Record Examination is required of candidates who seek to be considered for admission. The department offers the Master of Arts in political science and the Master of Public Administration.

**Master of Arts (M.A.) in Political Science**

The program leading to the Master of Arts in political science is normally to be completed in a single calendar year (an academic year plus the following summer) and is based on three elements: the development of advanced knowledge in at least three fields of the discipline in which the department offers its courses and seminars; the ability to conduct and complete an individual program of research at a high level; and familiarization with modern methodology in the discipline. Accordingly, every candidate will complete a suitably arranged program consisting of seven courses and seminars (28 credits) and a master's thesis (which carries 8 credits), for a total of 36 credits. The first four credits of Polt 899 are normally taken in the second semester of the candidate's residence. The remaining four credits of Polt 899 are taken during the semester in which the student expects to graduate. Theses topics must be approved by a committee nominated by the chairperson and appointed by the dean of the Graduate School.

An essential requirement is that candidates must arrange their programs so that they include at least one seminar or advanced course in each of the four fields of the discipline emphasized by the department (political thought, American politics, comparative politics, and international politics). The

remaining courses may be chosen according to the candidate's interests and needs, and two may be taken in a related field outside the department. Where candidates lack proficiency in tools of quantitative analysis or a foreign language essential to the program of study and research, they will be required to attain and demonstrate to their thesis advisers proficiency in the needed skill.

**Master of Public Administration (M.P.A.)**

The Master of Public Administration is an interdisciplinary degree designed principally for individuals intending to pursue careers in local, state, or national government service in the U.S. or other countries. Candidates will be expected to complete eight full courses (32 credits) and a four-credit internship program (Polt 870: Administrative Internship) for a total of 36 credits. Candidates who have had appropriate responsibility in public administration may be exempted from the internship upon petition for such exemption. Such candidates will be required to undertake independent research on an approved topic related to public administration (Polt 895 or 896, four credits). A recreation and parks option, which draws upon the resources of that department, is offered as an interdisciplinary program for the degree. Students pursuing this option are held to the general degree requirements and usually take courses in recreation and parks to fulfill the requirements for work outside the political science department. The internship is served with an appropriate recreation and parks agency.

Of the eight courses, at least three shall be chosen from the courses and seminars in public administration offered by the department (Polt 805: Methods of Policy Analysis; Polt 806: Theories and Processes of Public Administration; and Polt 807: Cases in Public Management), and two from other political science courses offered by the department according to the needs and interests of the candidate. The remaining three courses may be chosen from outside the department in such related fields as economics, administration, resource economics, sociology, and recreation and parks.

**American Politics and Public Administration**

**701/801. COURTS AND PUBLIC POLICY**

Impact of judicial decisions on public policy at federal, state, local, and regional levels. 4 cr.

**702/802. PUBLIC PLANNING AND BUDGETING**

Analysis, goal setting, and strategic planning in a governmental setting, with particular emphasis on budgetary processes as a means for controlling policy effectiveness. 4 cr.

**703/803. URBAN AND METROPOLITAN POLITICS**

Planning and management of the urban community, intergovernment relations, administrative functions, and general urban problems. 4 cr.

**704/804. POLICY AND PROGRAM EVALUATION**

Policy and program evaluation of federal, state and local governmental enterprise; focuses on the policies, practices, and methods of evaluative investigation. Evaluation as a technique for providing rational information for budgetary and policymaking decisions. 4 cr.

**797, 798/897, 898. SECTION B: SEMINAR IN AMERICAN POLITICS**

Advanced analysis and individual research. 4 cr.

**797, 798/897, 898. SECTION F: SEMINAR IN PUBLIC ADMINISTRATION**

Advanced analysis and individual research, including opportunities for direct observation of governmental administration. 4 cr.

**805. METHODS OF POLICY ANALYSIS**

Research design, survey methods, experimental techniques, and aggregate data analysis applied to public policy settings. 4 cr.

**806. THEORIES AND PROCESSES OF PUBLIC ADMINISTRATION**

Theories of organization and bureaucracy, the implications of bureaucratization, and the major processes of public administration including budgeting, personnel, policy making, as well as attention to contemporary policy issues including collective bargaining, affirmative action, citizen participation. 4 cr.

**807. CASES IN PUBLIC MANAGEMENT**

Policy case studies emphasizing politics, organizational structure, and interorganizational behavior; management case studies emphasizing behavior, human relations, personality, and intraorganizational dynamics; and simulation and role-playing exercises. 4 cr.

***Political Thought*****720/820. PERSPECTIVES ON POLITICAL SCIENCE**

Different views on the study and meaning of politics. Perspectives of political scientists, political philosophers, and political activists. 4 cr.

**721/821. ECONOMIC THOUGHT AND POLITICS**

Economic theories from the perspective of political thought. Economic activity and resource distribution in relation to historical and contemporary issues such as freedom, equality, authority, community, democracy, and quality of life. 4 cr.

**797, 798/897, 898. SECTION I: SEMINAR IN POLITICAL THOUGHT**

Advanced treatment and individual research. 4 cr.

***Comparative Politics*****741/841. POLITICS OF INDUSTRIALIZED STATES**

Impact of modern industrialism and its organization upon political life and the conduct of government. 4 cr.

**742/842. COMPARATIVE COMMUNIST SYSTEMS**

Interests, demands, and decision making in communist governments. Ideological issues, political behavior within communist international organizations, intraparty relations, distinctions between ruling and nonruling communist parties. 4 cr.

**797, 798/897, 898. SECTION C: SEMINAR IN COMPARATIVE POLITICS**

Advanced analysis and individual research on foreign nations or regions, focusing on governmental

institutions, foreign policy, political parties, or bureaucracy. 4 cr.

***International Politics*****760/860. THEORIES OF INTERNATIONAL POLITICS AND INTEGRATION**

General explanations of the behavior of nations; theory and practice of supra-national integration; theories of peace and security and community building at the international level; concepts and experience in arms limitations and conflict resolution. 4 cr.

**761/861. INTERNATIONAL LAW**

Formalized processes for regularizing state behavior; development of norms based on custom, precedent, and formal institutions, as in treaties and cases. Arms reduction and limitation arrangements; inspection, and other formal procedures designed to preserve peace. 4 cr.

**778/878. INTERNATIONAL ORGANIZATION**

Collective security and other forms of cooperation among nations through international organizations such as the United Nations and its predecessors, and through regional bodies. 4 cr.

**797, 798/897, 898. SECTION E: SEMINAR IN INTERNATIONAL POLITICS**

Advanced analysis and individual research; emphasis on developments in theory. 4 cr.

***General Courses*****870. ADMINISTRATIVE INTERNSHIP**

Practical administrative experience in an area of professional interest. Prereq: M.P.A. candidate. 4 cr.

**895, 896. READING AND RESEARCH IN POLITICAL SCIENCE**

A) American Politics; B) Comparative Politics; C) International Politics; D) Political Thought; E) Public Administration; F) Public Policy. The graduate student will engage in independent study under the direction of one of the members of the department. Requires approval of the graduate committee. 4 cr.

**899. MASTER'S THESIS**

Each student will carry out original research that culminates in a master's thesis. Must be taken 4 cr. per semester in each of two semesters. Maximum 8 cr. Cr/F.

***Related Courses in Recreation and Parks***

*For information, contact Associate Professor Gus Zaso, Department of Recreation and Parks.*

**885. COMPREHENSIVE PLANNING**

Leisure and tourist planning—local, county, and regional. Recreation programming and resource development. Legislative aspects, court decisions, administrative organization, zoning, land use, and other master planning considerations. Prereq: permission. 4 cr.

**890. SPECIAL TOPICS AND PROJECTS**

Advanced study in specific areas; may involve for-

mal classes, seminars, or independent projects. Prereq: permission. 4 cr.

## **Psychology (Psyc)**

**Chairperson:** John A. Nevin

**PROFESSORS:** Raymond L. Erickson; Gordon A. Haaland; John A. Nevin

**ASSOCIATE PROFESSORS:** William M. Baum; James R. Davis; Peter S. Fernald; Earl C. Hagstrom; David E. Leary; John E. Limber; Daniel C. Williams; William R. Woodward

**ASSISTANT PROFESSORS:** Ellen S. Cohn; Kenneth Fuld; R. Michael Latta; Carolyn J. Mebert; Rebecca M. Warner

**ADJUNCT ASSOCIATE PROFESSOR:** Robert G. Congdon

### ***Doctor of Philosophy***

The Department of Psychology offers a four-year program of study leading to the Doctor of Philosophy degree. The basic goal of the program is the development of behavioral scientists who can both carry out sound research in an area of specialization and teach effectively. Integral to the program is the development of specific skills required by the research psychologist who intends to become a college or university teacher. In order to develop these skills, each year the program required of all students includes a variety of research and instructional activities in addition to the usual academic work. In the third year, each student teaches small sections of introductory psychology under close staff supervision while concurrently enrolled in a teaching seminar that has among its objectives an increased appreciation of the goals and problems of teaching.

Areas in which the student may specialize are: history, learning, perception-cognition, developmental, physiological, and social psychology. The student's adviser will help the student to plan an effective graduate program. Core courses taken by all students include methodology, statistics, and the seminar and practicum in the teaching of psychology. Work outside the department also is included in each student's program. Depth in a particular area is obtained through participation in the graduate courses listed below and by independent study and research conducted under the supervision of a staff member. Psyc 895-896; Reading and Research in Psychology, is specifically designed to serve this purpose.

Prior to the doctoral dissertation, the student will carry out original research that culminates either in a master's thesis or a paper of publishable quality. A master's degree may be awarded upon the successful completion of a program approved by the department and dean of the Graduate School including original research at the master's level. Detailed information concerning the qualifying examination for advancement to candidacy for the Ph.D. degree and other requirements can be obtained from the department.

A student admitted to graduate study must meet the requirements for admission to the Graduate School. In applying for admission to the department's program, candidates must submit Graduate Record Examination scores on the verbal, quantitative, and analytical sections of the aptitude test and the score on the advanced test in psychology.

To be accepted into the program, the applicant must desire to pursue the doctoral degree and be deemed qualified to do so on the basis of initial selection procedures. The applicant need not necessarily have been an undergraduate major in psychology. However, before beginning a graduate career proper, the applicant must have completed a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics and experimental psychology.

The courses and seminars listed below provide the general framework within which the student will develop, with the counsel of the adviser, a program of research and study leading to the doctoral degree. The range and sequence of seminars varies to some extent with the student, though there will be common features to all programs.

The core graduate courses are offered whenever possible in a two-year cycle. Consult the department for exact schedule.

### **801-802. GRADUATE PROSEMINAR**

Students and graduate faculty in psychology meet every two weeks for a mutual exchange on current issues in psychology. 0 cr. Cr/F.

### **805-806. RESEARCH METHODOLOGY AND STATISTICS I-II**

A consideration of research techniques and problems of methodology in psychology. The first semester stresses the principles of statistical inference, correlational approaches, and their interrelatedness in design. Topics considered include probability theory, linear regression, function-free prediction, the theory underlying statistical inference, parametric and nonparametric tests of significance, and principles of analysis of variance. The second semester extends the correlational approach to the techniques and methodology of multiple regression and considers the appropriate use and theoretical bases of complex designs. Prereq: undergraduate statistics and experimental psychology. 3 cr.

### **807. RESEARCH METHODS AND STATISTICS III**

The application of multivariate methods of data analysis in psychological research: multiple regression, analysis of covariance, Hotelling's  $T^2$  multivariate analysis of variance, path analysis, discriminant functions, canonical correlation, factor analysis. 3 cr.

### **812. PSYCHOLINGUISTICS**

The use and development of human language: the nature of explanation, contemporary linguistic theory, semantics, functions of language, speech perception and production, learning. 3 cr.

### **814. COGNITIVE PROCESSES**

The complex mental processes that characterize people: concept formation, reasoning, problem-solving, symbol use, creative thinking, imagination, fantasy behavior, pathology of thought, consciousness and its alterations, and the relationship between cognition and effective behavior. 3 cr.

### **817. SENSORY AND PERCEPTUAL PROCESSES**

Anatomy, physiology, psychophysics, and perceptual processes of all the sensory modalities, with

emphasis on vision and visual perception. Topics include physics and measurement of light; brightness and contrast; color; spatial vision; depth perception; temporal vision; perceptual development. 3 cr.

### **831. PHYSIOLOGICAL PSYCHOLOGY**

Comprehensive survey of current concepts in the neurosciences. 3 cr.

### **833. ADVANCED SEMINAR IN PHYSIOLOGICAL PSYCHOLOGY**

In-depth examination of a specific topic in the neurosciences. Topics vary depending upon interests of instructor and students. Prereq: Psyc 831 or permission. 3 cr.

### **841. PSYCHOLOGY OF LEARNING AND MOTIVATION**

Survey of current theory and research, with emphasis on conditioning, reinforcement, and stimulus control. 3 cr.

### **845. ADVANCED RESEARCH TOPICS IN LEARNING**

Current empirical and theoretical issues in learning. Prereq: Psyc 841 or equivalent. 3 cr.

### **850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS**

Procedures, logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Experimental, quasi-experimental, and nonexperimental designs, the laboratory-field continuum, social psychological aspects of interviews and experiments, the nature of artifacts, and other current methodological issues. Emphasis on design of social psychological research rather than statistical analysis, though statistical matters regularly arise. Prereq: Psyc 805, Soc 801, or equivalent. 3 cr.

### **851. SOCIAL PSYCHOLOGY**

A seminar covering current topics in experimental social psychology including attitude change, power and influence, interpersonal perception and attraction, conformity, and social learning. 3 cr.

### **852. ATTITUDE AND ATTRIBUTION IN SOCIAL PSYCHOLOGY**

Various approaches to attitudinal and attributional processes; emphasis on current theoretical issues. Prereq: Psyc 851. 3 cr.

### **853. GROUP PROCESS AND SOCIAL INFLUENCE**

Problems of the individual in the group and the group as a system; aspects of social influence. Prereq: Psyc 851 or permission. 3 cr. (Not offered every year.)

### **854. SEMINAR IN SOCIAL PSYCHOLOGY**

Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students will participate directly in the conduct of the seminar by means of individual topical discussions, development and/or execution of research designs, and critical assessment of the current state of the topic area under discussion. Illustrative topics: political behavior, paralinguistics and nonverbal communication, ethnic and racial prejudice, and environmental psychol-

ogy. May be repeated for credit. Prereq: Psyc 851. 3 cr.

### **856. PSYCHOLOGY OF PERSONALITY**

Major theories and research methods in personality. 3 cr.

### **871. SURVEY OF THE HISTORY OF PSYCHOLOGY I**

Overview of the history of psychology up to the mid-nineteenth century. 3 cr.

### **872. SURVEY OF THE HISTORY OF PSYCHOLOGY II**

Overview of the history of psychology from the mid-nineteenth century to the mid-twentieth century. 3 cr.

### **873. METHODS AND THEORIES IN HISTORICAL RESEARCH ON THE BEHAVIORAL SCIENCES**

Major methods and theories used in historical research applied to the study of the behavioral sciences. Prereq: Psyc 871, 872, or permission. 3 cr.

### **874. PROBLEM AREAS IN THE HISTORY OF PSYCHOLOGY**

In-depth studies of particular individuals, movements, and/or subfields. Each student pursues own research project. May be repeated for credit. Prereq: Psyc 871, 872, or permission. 3 cr.

### **875. SPECIAL TOPICS IN THE HISTORY OF PSYCHOLOGY**

Topic to be determined when course is offered. May be repeated for credit. Prereq: Psyc 871, 872, or permission. 3 cr.

### **881. CHILD PSYCHOLOGY**

Devoted to topics of current interest in child psychology. Core material will be followed by in-depth study in an area of student's interest. 3 cr.

### **882. ADVANCED SEMINAR IN DEVELOPMENTAL PSYCHOLOGY**

In-depth analysis of one or several specific topics or issues in developmental psychology. Students will be expected to develop a research proposal with potential for submission as a pre-doc, post-doc, or regular grant. 3 cr.

### **891-892. PRACTICUM AND SEMINAR IN THE TEACHING OF PSYCHOLOGY**

Practicum offers the student an opportunity to teach introductory psychology under close supervision from the staff. The seminar is coordinated with this experience and focuses on both practical and theoretical issues of significance in the teaching/learning process at the college level. Required of all doctoral students, during the third year. 5 cr.

### **894. ADVANCED RESEARCH IN PSYCHOLOGY**

Student designs and conducts original research that culminates in a paper of publishable quality. Completion of either this course or Psyc 899 will satisfy the department's research requirement for the master's degree. May be taken for 3 cr. per semester in each of two semesters or 6 cr. in one semester. Maximum 6 cr. Cr/F.

**895-896. READING AND RESEARCH IN PSYCHOLOGY**

A) Physiological; B) Perception; C) History and Theory; D) Learning; E) Social; F) Cognition; G) Statistics and Methodology; I) Developmental; J) Psychopathology. As part of the development as an independent scholar, the student is encouraged to plan: 1) broad reading in an area; 2) intensive investigation of a special problem; or 3) experimental testing of a particular question. Requires approval of both adviser and staff member directing project. May be repeated. 3-6 cr.

**897-898. PROBLEMS AND ISSUES IN PSYCHOLOGY**

Seminar on a problem that has been the subject of specialized research and study by a member of the staff. Topic and instructor vary. May be repeated for credit. 3 cr. (Not offered every year.)

**899. MASTER'S THESIS**

Each student will carry out original research that culminates in a master's thesis. May be taken 3 cr. per semester in each of two semesters or 6 cr. in one semester. Maximum 6 cr. Cr/F.

**999. DOCTORAL RESEARCH**

*Graduate Course Offered Primarily for Students Enrolled in Other Graduate Programs*

**823. INDIVIDUAL TESTING**

Training in administration, scoring, and behavioral observation necessary for interpretation of individual tests of intelligence with discussion and demonstration of certain other instruments for cognitive measurement. The focus will be on children rather than adults, and on technique rather than interpretation. Each student will be required to purchase one set of materials. (Student's background in statistics, measurement, exceptional child, and personality theory will be evaluated by the instructor.) Prereq: permission. Lab. 4 cr.

## Sociology (Soc)

**Chairperson:** Arnold S. Linsky

**PROFESSORS:** Melvin T. Bobick; Walter F. Buckley; Bud B. Khleif; Arnold S. Linsky; Stuart H. Palmer; Solomon Poll; Murray A. Straus

**ASSOCIATE PROFESSORS:** Charles Bolian; Peter Dodge; Richard E. Downs; Melville Nielson; Stephen P. Reyna; Fred Samuels; Howard M. Shapiro

**ASSISTANT PROFESSORS:** Lawrence C. Hamilton; Barbara K. Larson; Sally K. Ward  
**GRADUATE PROGRAM COORDINATOR:** Peter Dodge

The Department of Sociology and Anthropology offers M.A. and Ph.D. degrees in sociology. The master's degree program emphasizes theory and methodology. Students in the doctoral program are expected to select from the areas of departmental specialization one major area—and from the areas of expertise found among the faculty, one minor area—for intensive study and examination. There are four major substantive areas for possible specialization: deviance, conflict, and control; social psychology; comparative institutional analysis; and family. Students may pursue

specialties within or across the major areas of specialization, or propose to the Graduate Committee other major areas of specialization which fall within the faculty's competence.

Students' proficiency in theory, statistics, and methods, and in the major and minor areas of study, is determined by written examinations. Details about the examinations can be found in the *Graduate Student Handbook*, which is sent to all students requesting information about the program. Within the context of a curriculum organized largely in the form of seminars and research, students may design, with the approval of advisers and the Graduate Committee, curricula suitable to their experience and intellectual goals. In line with this flexibility, choice may include courses in anthropology and up to three courses from outside the department. Selection of thesis and dissertation topics is limited only by the areas of expertise available among departmental faculty members.

Upon establishing residence, students will be responsible for remaining informed about any modifications in the requirements of the degree program in which they are enrolled.

To be awarded the **Master of Arts** degree the candidate must fulfill the following requirements: 1) Complete satisfactorily at least one full year (24 credit hours) of graduate-level course work in sociology including Sociological Methods I (801), and either 802, 803, or 804; and Sociological Theory I (811). 2) Register for one credit of thesis work during the second semester of residence and submit a draft of a proposal to the thesis committee by the end of the semester. The proposal or abstract must be circulated to all department faculty. 3) Submit for approval a report of a research endeavor to the thesis committee. This report may be in the form of either a) a thesis or b) a publishable paper in the form outlined in the publication format of any major sociological journal.

Students interested in nonacademic employment after completing a degree in sociology should take as one of their electives a field experience or internship course involving experience in a nonacademic setting. This can be done under Sociology 895, by arrangement among the student, a faculty member, and the organization in which the field experience/internship will be located. Experience of this type is extremely important for placement in nonacademic positions. The expectation is that an academic paper will be required in conjunction with the field experience.

To be awarded the **Doctor of Philosophy** degree, the candidate must fulfill the residence requirement of three years' work after the bachelor's degree including: 1) a minimum of 12 courses in sociology (at least 8 as seminars), other than thesis or dissertation research, including Sociological Theory I and II (811 and 812), Sociological Methods I and II (801 and 802), and one other course in methods or statistics (803 or 804), three courses in a major area, and two in a minor area of sociology; 2) a second minor consisting of three related courses whether or not sociological in content—no preliminary examination is required; 3) passing written examinations in the major and minor areas of sociological specialization and in advanced theory and methodology; 4) demonstrating reading level proficiency in a foreign language or a research tool appropriate to the overall program of the student (the research tool option must not be part of the other degree requirement for graduate students in sociology; examples of appropriate research tools include computer programming, symbolic

logic, historiography, econometric techniques, and mathematical statistics. At the time they are admitted to the Ph.D. program, students must submit, for approval by the Graduate Committee, a statement indicating how they intend to meet the language/research tool requirement); 5) fulfilling the research and/or teaching requirement described below; 6) writing and defending an acceptable doctoral dissertation.

In planning the program of study, the student will be advised at first by an assigned faculty member and, subsequently, in the case of doctoral students, by a guidance committee. Specially appointed committees will be organized for the direction and assessment of the thesis and dissertation. Under such supervision, students are expected to go considerably beyond the minimum common requirements of the graduate program to establish a knowledgeability and competency peculiarly their own, and they will be permitted to take courses outside the department or below the 700 level within the department only with the express permission of their advisers.

Students are permitted to register for Reading and Research in Sociology and Anthropology (895, 896) to pursue their individual interests. Upon completion, work done under this rubric will be reported, in writing, to the Graduate Committee and the student's adviser by the faculty member who assumes the responsibility for supervising such activities.

In all cases, students having knowledge equivalent to any of the required courses may substitute an examination to be given by the faculty member responsible for the course. Full credit for the fulfillment of requirements may be given to equivalent courses taken elsewhere.

An important part of the graduate program is the opportunity to learn from participation in the teaching and research activities of the department faculty. All candidates for doctoral degrees are therefore expected to assist a member of the department in teaching and/or research. Assignments to work with a specific member will be made by the Graduate Committee on the basis of students' experience, the needed areas of training, and the interests and preferences expressed by the students and faculty members.

To be accepted as a graduate student in sociology, applicants must present, in addition to meeting the general Graduate School requirements, Graduate Record Examination scores on the verbal, quantitative, and analytical tests, and the advanced sociology test. Undergraduate majors in other fields may be admitted, in which case advanced tests in their majors may be required. However, if the student's undergraduate work has not included an introductory course in sociological theory, research methods, statistics, and two other sociology courses, these five courses must be taken—or equivalent knowledge demonstrated through examination—in addition to the requirements outlined above.

All students entering the program must complete the M.A. before admission to the Ph.D. program. The department welcomes both applicants who plan to continue for the Ph.D. as well as students planning for the M.A. only.

## **715. SOCIOLOGY OF CRIME AND JUSTICE**

Seminar devoted to analyses of the relationships between violent, property, and "victimless" crime

on the one hand and the police, judicial, and correctional components of criminal justice systems on the other. Prereq: intro criminology or permission. 4 cr.

## **720. CURRENT DEVELOPMENTS IN SOCIOLOGY OF THE FAMILY**

A current topic will be selected each semester, such as stratification and the family, intrafamily communication, power structure of the family, kinship in modern societies. Critical review of the literature; class or individual research project usually will be carried out. Prereq: 8 credits of sociology; a family course recommended. 4 cr.

## **721. FAMILY INTERACTION**

Analysis of family interaction from a sociological perspective. Consideration of individual family members, relationships, and the family as a unit using a social systems approach. Prereq: intro soc or permission. 4 cr.

## **735. COMPLEX ORGANIZATIONS**

Comparative study of the structure and dynamics of complex, formal organizations (business, military, political, and governmental, educational, medical). Power and social control in formal systems; organizational processes, performances, and effectiveness; effect of complex, formal organizations on persons and societies. Prereq: permission. 4 cr.

## **740. CULTURE CHANGE**

Various types of society; development of theory. Descriptive studies of institutional as well as theoretical materials selected from the writings of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. 4 cr.

## **741. SOCIAL CHANGE AND SOCIETAL DEVELOPMENT**

Comparative, interdisciplinary approach. Interrelationships among economic, political, and social factors in determining the structure, dynamics, character, and level of development of societies. Prereq: permission. Soc 740 recommended. 4 cr.

## **745. SOCIAL STRATIFICATION**

Pattern of distribution of economic, honorific, and political variables within the populations of complex societies; allocation of personnel to the roles in question, notably through occupational mobility; and the impact of such processes upon behavior, both individual and social. Prereq: intro soc or social institutions. 4 cr.

## **750. THE MIDDLE EAST: ISSUES OF ETHNICITY, WORK, AND IDENTITY**

Community studies approach to such topics as: ethnicity and identity in the interrelationship of language, religion, and corporate membership in a community; ethnic division of labor; work, pluralism, and family networks; mobility and immobility; estates vs. classes. 4 cr.

## **757. SOCIAL INSTITUTIONS OF LATIN AMERICA AND THE CARIBBEAN**

Selective analysis of distinctive institutions and social systems, with particular attention to social aspects of the process of modernization. Prereq: permission. 4 cr.

**761. POPULATION DYNAMICS**

Major population trends including changes in birth and death rates, population characteristics, mobility, migration, world population growth, population problems, and policies of countries at different stages of economic development. Interrelationship of population and society. 4 cr.

**770. CULTURE, PERSONALITY, AND SOCIETY**

A cross-cultural view of the development of personality as emergent from genetic, situational, and socio-cultural determinants; analysis of the dynamic interplay of socio-cultural and psychological behavior systems. Prereq: prior courses in sociology, anthropology, or psychology. 4 cr.

**780. SOCIAL CONFLICT**

Nature of social conflict, especially war. Setting and initiation of conflict, its dynamics, and factors affecting its course and outcomes. Prereq: permission. 4 cr.

**785. THE STUDY OF WORK**

Understanding society through the structure of work. Case studies, in an ethnographic manner, of high-status and low-status occupations to provide understanding of social processes and interrelationships in the social structure. 4 cr.

**790. APPLIED SOCIOLOGY**

1) Current level of use of sociological knowledge; 2) the advocate, consultant, and researcher roles in applied settings; 3) techniques of applied research; 4) implications of applied sociology, including ethical problems. Each student will focus on a social problem and write a paper covering the above issues. Applied projects where possible. Prereq: meth of soc res. 4 cr.

**794. EVALUATION OF SOCIAL PROGRAMS**

Evaluation research defined: purposes of evaluation; design of evaluation studies; setting of programs; utilization of evaluation results. Examination of case studies of evaluations of social programs. Students are responsible for designing an evaluation study in their chosen substantive area. Prereq: meth of soc res. 4 cr.

**795, 796. READING AND RESEARCH IN SOCIOLOGY**

A) Communications; B) Criminology; C) Culture Change; D) Culture and Personality; E) Deviant Behavior; F) Family; G) Population; H) Rural-Urban; I) Social Control; J) Social Differentiation; K) Social Movements; L) Social Psychology; M) Social Research; N) Social Theory. Prereq: 12 credits of sociology or permission. 2-8 cr.

**797. SPECIAL TOPICS IN SOCIOLOGY**

A) Criminal Justice Field Work; B) Sociology of Crime and Justice; C) Sociology of Mental Health and Illness; D) Illness and Society; E) The Holocaust; F) Socio-Linguistics; G) Social Class and Family Patterns; H) Measurement in Sociology; I) Violence in the Family; J) Post-Industrial Society; K) Political Sociology; L) Bio-Sociology; M) Social Evolution; N) Social Differentiation; O) Modernization; P) Blacks in the Americas; Q) Religious Movements; R) American States and Regions. New or specialized courses presenting material not normally covered in regular course offerings. May be repeated, but not in duplicate

areas. Course descriptions and prerequisites on file in department office during registration. 4 cr.

**801. SOCIOLOGICAL METHODS I: INTERMEDIATE SOCIAL STATISTICS**

Application of statistical methods to the analysis of social data, with particular emphasis on multiple regression and related topics. 4 cr.

**802. SOCIOLOGICAL METHODS II: RESEARCH DESIGN**

Systematic investigation of each step in the design and implementation of sociological research. Selected techniques of data collection and analyses will be pursued. Prereq: meth of soc res; soc stat; or their equivalents; or permission. 4 cr.

**803. SOCIOLOGICAL METHODS III: SPECIAL PROBLEMS IN METHODS AND STATISTICS**

Course alternates among special problems, such as measurement, and advanced statistics. 4 cr.

**804. SOCIOLOGICAL METHODS IV: FIELD WORK**

Training for participant observation in the manner of an anthropologist or Chicago-school sociologist. Students write and discuss field notes and become familiar with case studies, content analysis, and relevant issues. Field notes, basis for a term paper. 4 cr.

**811. SOCIOLOGICAL THEORY I**

The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prereq: hist of soc theory; contemp soc theory; or their equivalents. 4 cr.

**812. SOCIOLOGICAL THEORY II**

The content, presuppositions, and implications of contemporary sociological theory. Students will engage in theory construction and analysis, and in this endeavor will be encouraged to develop their particular interests in substantive areas. Prereq: Soc 811. 4 cr.

**813. SOCIOLOGICAL THEORY III**

A seminar of intensive study of topics in sociological theory. Sample topics include: exchange theory, functionalism, systems theory, theory construction, pioneering theorists. Prereq: hist of soc theory; contemp soc theory; or their equivalents. 4 cr.

**821. DEVIANT BEHAVIOR**

Relationships among cultural, subcultural, and personality variables and deviant behavior; forms of deviant behavior: invention, crime, alcoholism, and emotional illness. Prereq: permission. 4 cr.

**830. THE SMALL GROUP**

Sociological and social psychological perspectives on interaction within small groups. Prereq: courses in sociology and social psychology, or permission. 4 cr. (Not offered every year.)

**832. FAMILY INTERVENTION**

Application of sociological and social psychological theory and technique to clinical intervention in families; principles of problem formulation and resolution in family intervention; therapy for differing family units: individuals, relationships, subgroups, and whole families; consideration of

types of change that occur in family therapy, both planned and spontaneous; strategies of intervention; and practical issues involved in family intervention. Selected attention to specific problems such as separation and loss, drug abuse and violence. Prereq: permission. 4 cr.

### **838. SOCIOLOGY OF EDUCATION: SOCIAL ORGANIZATION OF SCHOOLS AND COMMUNITY**

Schools in their sociocultural contexts and as part of the institutional network of society. Relation to stratification and social control. Teaching as a religious occupation and as an emergent profession. 4 cr.

### **842. SOCIOLOGY AND THE POLICY-MAKING PROCESS**

Social policy and public policy defined: description of the policy-making process. The political sociology of the policy-making process; who makes policy and who influences policy, under what conditions, and with what effect. Definition of social policy research and the various roles social scientists can adopt for policy-relevant work. Students are responsible for critiquing the readings and for preparing a substantial research paper. 4 cr.

### **850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS**

The logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Experimental and nonexperimental designs, the social-psychological aspects of laboratory and field research, the nature of artifacts, etc. Emphasis is on research design rather than statistical analysis, but graduate-level sophistication in statistics is assumed. (Also offered as Psyc 850.) 4 cr.

### **851. SEMINAR IN SOCIAL PSYCHOLOGY**

Some of the major themes in social-psychological theory, including social structure and personality, socialization, small-group processes, and interaction analysis. Students will be expected to read and evaluate selected empirical research. 4 cr.

### **852. SOCIALIZATION AND ABNORMAL BEHAVIOR**

Orientations that relate socialization to abnormal behavior; synthesizes the major concepts into current sociological and social psychological frame of reference. Prereq: at least one course in social psychology or permission. 4 cr.

### **854. SOCIOLOGY OF RELIGION**

The reciprocal relationship of religion and culture; the function of religion in society; the contributions of sociological research; the relationship between religion and other social institutions; religion and social change; and the problem of church and state. 4 cr.

### **861. DEMOGRAPHY**

Current problem areas in demography including population theory, formal demography, social epidemiology, social indicators, use of demographic sources and techniques in sociological investigation. Prereq: Soc 761 or permission. 4 cr.

### **870. COMPARATIVE INSTITUTIONAL ANALYSIS**

Theory and methods of cross-national approaches, including: history, variations in objectives and

methods, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prereq: permission. 4 cr.

### **875. SOCIOLOGY OF THE FAMILY**

Major approaches in the sociological study of families. Individuals in families, family relationships, and families as groups and the interrelationships among these levels. Interactional and systemic properties of marriage, parent-child relations, and extended family relations. 4 cr.

### **880. SOCIAL DIFFERENTIATION**

Seminar allowing intensive examination of selected topics in differentiation and personnel allocation, with sections rotated among faculty members, in 1) social stratification, 2) race and ethnic relations, and 3) age and sex. Prereq: social stratification and either race and ethnic relations or female, male, and society. 4 cr.

### **885. OCCUPATIONS AND PROFESSIONS**

Professionalization as adult socialization, an acquisition of a new identity. Professions as ideologies, markets, and extended families. Research perspective of the Chicago School of Sociology. 4 cr.

### **888. SOCIOLOGY OF EDUCATION: THE CULTURES OF POVERTY AND AFFLUENCE**

The schooling of "culturally deprived" and "culturally endowed" pupils. Problems of social and geographic mobility and immobility. Rise of the counseling and healing trades. 4 cr.

### **889. SOCIOLOGY OF EDUCATION: RACE AND ETHNIC RELATIONS IN SCHOOLS AND SOCIETY**

Ethnic stratification inside and outside the school. The schooling of whites and nonwhites. Issues of bilingualism, culture, and identity. 4 cr.

### **895, 896. READING AND RESEARCH IN SOCIOLOGY AND ANTHROPOLOGY**

A) Communications; B) Criminology; C) Cultural/Social Anthropology; D) Culture Change; E) Culture and Personality; F) Deviant Behavior; G) Prehistoric Archaeology; H) Family; I) Population; J) Rural-Urban; K) Social Control; L) Social Differentiation; M) Social Movements; N) Social Psychology; O) Social Research; P) Social Theory; Q) Anthropological Linguistics; R) Social Welfare. A student prepared by training and experience to do independent work under the guidance of an instructor may register for one or more of these sections. Prereq: 16 graduate hours of sociology and permission. Hours and credit to be arranged.

### **897. SPECIAL TOPICS IN SOCIOLOGY**

A) Criminal Justice Field Work; B) Sociology of Crime and Justice; C) Sociology of Mental Health and Illness; D) Illness and Society; E) The Holocaust; F) Socio-Linguistics; G) Social Class and Family Patterns; H) Measurement in Sociology; I) Violence in the Family; J) Post-Industrial Society; K) Political Sociology; L) Bio-Sociology; M) Social Evolution; N) Social Differentiation; O) Modernization; P) Blacks in the Americas; Q) Religious Movements; R) American States and Regions. New or specialized courses presenting material not normally covered in regular course

offerings. May be repeated, but not in duplicate areas. Course descriptions and prerequisites on file in department office during registration. 4 cr.

### **899. MASTER'S THESIS**

Usually 6 cr. but up to 10 cr. when the problem warrants.

### **999. DOCTORAL RESEARCH**

## **Spanish (Span)**

**Chairperson:** F. William Forbes

**PROFESSORS:** Richard J. Callan; R. Alberto Casás; Charles H. Leighton

**ASSOCIATE PROFESSOR:** F. William Forbes

**ASSISTANT PROFESSORS:** Linda D. East; Bernadette Komonchak; Barbara H. Wing

### **Master of Arts**

To be admitted to graduate study for the Master of Arts degree in Spanish, a student must have completed 30 credits in Spanish language and literature beyond first year Spanish, including a survey of Spanish literature and two other literature courses. To obtain the degree, the student must fulfill the course requirements, pass a comprehensive examination based on a master's degree reading list, and submit an acceptable thesis if such an option is chosen.

To satisfy the course requirements, the student must: a) successfully complete 10 graduate courses (of which eight should be from the Spanish offerings); or, b) successfully complete at least eight courses in Spanish and submit a thesis (6 credits, thus completing the minimum of 30 credits required by the Graduate School). All advanced literature courses are conducted in Spanish.

In addition, M.A. students are required to take 801. Teaching assistants must also take 803. No student may register for a graduate course if he or she has already taken the corresponding undergraduate course here or its equivalent elsewhere.

A comprehensive examination based on a master's degree reading list will be given four times a year; in January, May, August, and September. The candidate will be permitted to take the examination only twice. Students failing their first attempt must wait at least three months before taking it again. The thesis option must embody the results of independent investigation and be written in a form acceptable to the Spanish section. It must be submitted to the thesis director six weeks before expected time of degree conferral.

### **801. BIBLIOGRAPHY AND METHODS OF RESEARCH**

Required of all graduate students in their first year of study. An introduction to standard bibliographical techniques and to form and style in the preparation and writing of research findings. Preparation of a research paper. 1 cr.

### **803. APPLIED LINGUISTICS**

Required of all graduate assistants teaching in the departmental program, but open to all graduate students in Spanish. Discussion of current methodology and linguistic approaches to the teaching

of Spanish. Instruction in the use of audio-visual aids including language laboratories. Readings, discussion, class observation. May be repeated for a total of 3 cr. 1 cr.

### **811. MEDIEVAL SPANISH LITERATURE**

Spanish literature including social and historical backgrounds, 1100-1500: *Poema de mio Cid*, Berceo, *Mester de clerecia*, *Libro de buen amor*, *Cancionero* poets, and *La Celestina*. 3 cr. (Not offered every year.)

### **831. RIVER PLATE LITERATURE**

Sarmiento, José Hernández, Rodó, Florencio Sánchez, Mallea. Focus on the question of *Argentinidad*. 3 cr. (Not offered every year.)

### **852. DRAMA AND POETRY OF THE SIGLO DE ORO**

Social and historical background of Baroque period. Representative plays of Lope de Vega, Tirso de Molina, Calderón; lyric poetry of Lope, Góngora, and Quevedo; prose developments. 3 cr. (Not offered every year.)

### **854. CERVANTES**

Cervantes's literary art. Selections from the major works. The *Quijote*, its originality and significance; its antecedents; its religious, philosophical, and sociological aspects; and its artistic structure. 3 cr. (Not offered every year.)

### **855. LITERATURE OF THE 19TH CENTURY**

Larra, Espriñeda, Bécquer, Pérez Galdós, and Blasco Ibáñez. Romanticism, realism, and naturalism. 3 cr. (Not offered every year.)

### **857. THEATER AND POETRY OF THE 20TH CENTURY**

The Generation of 1898 and *Modernismo*: Lorca, Casona, Buero Vallejo, Sastre, Salinas, Guillén, and Miguel Hernández. 3 cr. (Not offered every year.)

### **858. SPANISH PROSE OF THE 20TH CENTURY**

Novels, short stories, and essays. Unamuno, Ba-roja, Menéndez Pidal, Ortega y Gasset, Julián Mariás, Aranguren, Pérez de Ayala, Gironella, and Cela; survey of contemporary prose. 3 cr. (Not offered every year.)

### **860. UNAMUNO AND ORTEGA Y GASSET**

Philosophical ideology and literary content of major contributions of Miguel de Unamuno and José Ortega y Gasset. 3 cr. (Not offered every year.)

### **871. LATIN AMERICAN DRAMA**

From pre-Hispanic origins to the present; modern playwrights of Mexico and Puerto Rico. 3 cr. (Not offered every year.)

### **872. LATIN AMERICAN NOVEL**

Development from Romanticism to the present; contemporary trends and techniques. 3 cr. (Not offered every year.)

### **873. LATIN AMERICAN SHORT STORY**

Representative authors; stress on 20th century. Principles of interpretation. 3 cr. (Not offered every year.)

**874. MAJOR LATIN AMERICAN AUTHORS**

3 cr. (Not offered every year.)

**890. ADVANCED SPANISH GRAMMAR**

Review of Spanish grammar and syntax. Prereq: advanced composition and conversation. 3 cr.

**891. METHODS OF FOREIGN LANGUAGE TEACHING—SPANISH**

Interdepartmental course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary grades through college. Discussion, demonstration, preparation of instructional materials, microteaching of the language skills. Prereq: permission. 3 cr.

**895. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE**

A) The History of the Spanish Language; B) Medieval Spanish Literature; C) Spanish Literature of the Renaissance; D) Spanish Literature of the Golden Age; E) Spanish Literature of the 18th and 19th Centuries; F) Spanish Literature of the 20th Century 1898–1936; G) Contemporary Spanish Literature; H) Latin American Literature of the 16th and 17th Centuries; I) Latin American Literature of the 18th and 19th Centuries; J) Latin American Literature of the 20th Century; K) Contemporary Latin American Literature; L) Structural and Applied Linguistics; M) Spanish Literary Criticism; N) Latin American Essay; O) Latin America; P) Catalan; Q) Spanish Poetry; R) Latin American Poetry; S) Galdós; T) Archetype Latin American Literature; U) Special Teaching Problems; V) Spanish Civilization and Culture; W) Latin American Civilization and Culture; X) Borges; Y) Spanish Theater; Z) Spanish for Graduates. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prereq: permission of major supervisor. 1 or 3 cr.

**896. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE**

A) Hispanic Minorities of the United States; B) Portuguese; C) Introduction to Hispanic Linguistics; D) Hispanic Dialectology. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prereq: permission of major supervisor. 1–3 cr.

**899. MASTER'S THESIS**

6 cr.

## Zoology (Zool)

**Chairperson:** John E. Foret

**PROFESSORS:** Arthur C. Borror; Wilbur L. Bullock; Robert A. Croker; Evelyn E. Handler; Frank K. Hoornbeek; John J. Sasner, Jr.; Philip J. Sawyer

**ASSOCIATE PROFESSORS:** John E. Foret; Edward N. Francq; James F. Haney; Larry G. Harris; Marcel E. Lavoie; Edward K. Tillinghast; Charles W. Walker

**ASSISTANT PROFESSORS:** W. Hunting Howell; James T. Taylor; Winsor H. Watson III

**ADJUNCT ASSISTANT PROFESSOR:** John B.

Heiser

**GRADUATE PROGRAM COORDINATOR:**

John J. Sasner, Jr.

The graduate program in zoology is intended for students who aspire to a professional career within or outside the area of college teaching and research. Degrees can be earned with emphasis in behavior, development, ecology (freshwater and marine), endocrinology, fisheries, genetics, invertebrate zoology, mammalogy, neurobiology, parasitology, and physiology.

To be admitted to graduate study in zoology, students ordinarily must have completed an undergraduate major in biology or zoology. A basic array of courses including general biology, development, general ecology, genetics, morphology, and physiology is normally required. Additionally, a background in chemistry through organic chemistry and a semester each of calculus and physics is necessary. Students who are deficient in any of these requirements may be admitted to graduate status but may be required to remedy their deficiencies by taking courses which do not give graduate credit. Applicants are requested to submit aptitude and advanced biology scores for the Graduate Record Examination.

Each newly accepted graduate student will be interviewed during the second week of classes of the first semester. This interview will be conducted at a specified time by a committee composed of the student's temporary academic adviser plus two additional faculty members. The purpose of this committee is to advise the student in constructing a program of study and to correct such academic deficiencies as may exist. The committee will have available transcripts, letters of recommendation, and the results of the diagnostic exam described below. The committee will then enter its evaluation and recommendations in the student's permanent record.

All incoming graduate students will take a diagnostic exam before classes begin. This will include questions from the areas of behavior, biochemistry and physiology, development, ecology, evolution and systematics, genetics, morphology, parasitology, and general biology. No student is expected to do uniformly well in all areas, but a high level of competence is expected in those areas relevant to the student's particular program. Should the interview committee, on the basis of this exam, consider that a deficiency exists, this may be remedied either by a formal course or by an oral examination upon recommendation of the committee. Such oral examinations will be given during the week immediately following the spring vacation.

Students who hold a teaching assistantship will be given ample opportunity for practice teaching under the supervision of the instructor. All other graduate students are also required to obtain some appropriate teaching experience.

A candidate for the Master of Science degree in zoology, in addition to the requirements mentioned above, will ordinarily complete a special problem (Zool 895 or 896) of no more than 6 credits or a thesis of no more than 10 credits that is acceptable to the guidance committee. Prior to the receipt of the master's degree, all candidates must pass a comprehensive examination, which will include questions covering general knowledge in zoology in addition to specific questions relevant

to the candidate's University of New Hampshire experience.

All doctoral students must pass a written examination to certify their proficiency in one foreign language. Some fields of pursuit may require more languages and this need will be determined by the student's guidance committee.

After the successful completion of the language requirements and of all required courses, students who wish to be admitted to doctoral candidacy must demonstrate a broad basic knowledge of their major and minor fields in a qualifying examination, administered by the guidance committee. In addition, students must convince their proposed major professor and doctoral committee, in whatever way the committee finds acceptable, of their superior capacity to carry out basic research in biology. Normally, the student may accomplish this by presenting to the committee a research proposal in which the soundness, originality, and feasibility of the investigative ideas are clearly revealed, and which—when approved—should serve as the basis of the doctoral dissertation.

#### **704. COMPARATIVE ENDOCRINOLOGY**

Endocrine organs; relationship to control of the internal environment, growth, development, and adaptation to external environment. Prereq: vertebrate anatomy; physiology; organic chemistry. 4 cr.

#### **707. HUMAN GENETICS**

Inheritance patterns; gene and chromosome mutation rates and effects; linkage and gene frequency. Prereq: prin of genetics or equivalent; /or permission. 4 cr. (Not offered every year.)

#### **711. NATURAL HISTORY OF COLD-BLOODED VERTEBRATES**

Classes of poikilothermic vertebrates; their habits, habitats, and life histories in eastern North America. Prereq: general zoology; vert morph. Lab. 4 cr.

#### **712. MAMMALOGY**

Origins, diversification, reproduction, ecology, behavior of mammals. Identification of local forms. Prereq: prin of zool; vert morph. Lab. 4 cr.

#### **713. ANIMAL BEHAVIOR**

Individual and social behavior. The role of anatomy, physiology, ecology, and prior experience. Techniques and practical application. Prereq: one year of zoology. Lab. 4 cr.

#### **715. NATURAL HISTORY OF MARINE INVERTEBRATES**

Field and laboratory course; inshore marine invertebrate metazoan animals of northern New England. Identification, classification, habitat preferences, and behavior. Work (collection and observation) constitutes a major part of the course. Some travel expense. Prereq: general zoology. 6 cr. (Summer only; not offered every year.)

#### **717. GENERAL LIMNOLOGY**

Special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prereq: gen ecol; /or equivalent. 4 cr.

#### **719. FIELD LIMNOLOGY**

Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: present or prior enrollment in Bot 717, Zool 717, or equivalent; permission. 4 cr.

#### **720. FIELD MARINE SCIENCE FOR TEACHERS**

Primarily for teachers grades 6 through 12, but open to others. Overview of living marine organisms (algae, invertebrates, fishes, marine mammals, and shore birds) in their natural environments. Also such topics as coastal zone problems, marine fisheries, economics of marine organisms, and the educational resources of the marine environment. Field work. Offered at the Shoals Marine Laboratory (Isles of Shoals) in cooperation with Cornell University. Three lectures and two labs or field trips per day. Prereq: college-level intro biol. 1 cr. (Summers only.)

#### **721. PARASITOLOGY**

Introduction to the more important parasites causing disease in humans and animals. Living materials will be used as much as possible. Prereq: one year of zoology. Lab. 4 cr. (Not offered every year.)

#### **723. CELL PHYSIOLOGY**

Principles of chemistry and physics applied to understanding cell structure and function. Metabolic reactions and their control in relation to cell organization; genesis and function of specialized cells. Prereq: organic chemistry. Lab. 4 cr.

#### **728. DEVELOPMENTAL BIOLOGY OF THE INVERTEBRATES**

Principles of animal development including a modern discussion of the cellular processing of developmental information and a panoramic view of reproduction and development in the invertebrates. Prereq: prin of zool or intro to invert zool. Lab. 4 cr.

#### **730. VERTEBRATE HISTOLOGY**

Microscopic anatomy of vertebrate tissues and organs at the light microscope level; emphasis—mammalian histology; some comparative study of lower vertebrates. Prereq: hum anat and phys, vert morph, or equivalent. Lab. 4 cr.

#### **732. SOIL ZOOLOGY**

Faunal communities of terrestrial soils, their ecology and natural history. Effects of animal activities on soil processes and composition. Collection, extraction, and study methods. Independent projects. Prereq: gen ecol or equivalent; permission. 4 cr. (Not offered every year.)

#### **740. BIOLOGY OF ANIMAL REGENERATION**

Principles of regeneration in various animal phyla. Discussion of experimental studies supplemented by laboratory work with living animals. Prereq: prin zool. Lab. 4 cr. (Not offered every year.)

#### **751. ADAPTATIONS OF MARINE ORGANISMS**

Ecological physiology of selected algae and invertebrates from the Gulf of Maine. Offered at the Shoals Marine Lab (Isles of Shoals) in cooperation with Cornell University. Prereq: field marine sci-

ence, plant or animal physiology, physiological ecology; understanding of chemical quantitative methods and analysis. 4 cr. (Summer Session only.)

### **753. MARINE VERTEBRATES**

Lectures, laboratories, and field work on the systematics, ecology, and physiology of fishes, marine reptiles, marine birds, and marine mammals of the Gulf of Maine. Offered at the Shoals Marine Lab (Isles of Shoals) in cooperation with Cornell University. Prereq: field marine science or vertebrate biology. 4 cr. (Summer Session only.)

### **772. FISHERIES BIOLOGY**

Information and techniques used by fisheries biologists. Emphasis on fish life history, ecology, and economics as related to management techniques. Prereq: Zool 711 or equivalent; permission. Lab. 4 cr.

### **774. SALMONID BIOLOGY AND CULTURE**

Emphasis on the most important North American species of salmonids; life histories, anatomy, physiology, stocks of fishes, hatcheries, water quality requirements, economics, and politics. Closed-cycle culture techniques. Occasional Saturday field trips. Prereq: permission. 4 cr.

### **775. INVERTEBRATE EMBRYOLOGY**

Comparative study of reproduction and early development in selected invertebrates, providing a classical approach to morphology of gonads, fertilization, cleavage, gastrulation, and formation of larvae. Prereq: field marine sci (UNH), Biol Sci. 364 (Cornell), or invertebrate zoology. Offered at the Shoals Marine Lab (Isles of Shoals) in cooperation with Cornell University. 4 cr. (Summer Session only; not offered every year.)

### **777. INTRODUCTION TO NEUROBIOLOGY**

The nervous system, with emphasis on vertebrate and invertebrate preparations that most clearly demonstrate the basic concepts of neurobiology. Topics include: structure and function of neurons, development, cellular basis of behavior (sensory and motor systems), neuropharmacology, and neural plasticity (learning). Prereq: prin zool or permission. 4 cr.

### **778. COMPARATIVE NEUROPHYSIOLOGY**

Designed for students of the behavioral and physiological sciences who wish to understand the basic electrophysiological properties of neurons and how they interact. Both invertebrate and vertebrate systems will be called upon to illustrate principles of synaptic transmission, integration, sensory information processing, and the control of movement. Prereq: intro to neurobiology or permission. Lab. 4 cr.

### **795, 796. SPECIAL PROBLEMS IN ZOOLOGY**

B) Ecology; C) Endocrinology; D) Evolution; E) Developmental Biology; F) Genetics; G) Histology; H) History of Zoology; I) Invertebrate Zoology; J) Physiology; K) Vertebrate Zoology; L) Zoogeography; M) Zoological Techniques; N) Parasitology; O) Histochemistry; P) Protozoology; Q) Systematics; R) Animal Behavior; S) Teach-

ing Practices; T) Underwater Research. Students may elect one or more sections for advanced study. Reading, laboratory work, organized seminars, and/or conferences. Prereq: permission. (Limit of 12 cr. from the sections of this course.) 1-4 cr.

### **803. MARINE ECOLOGY**

Marine environment and its biota, emphasizing intertidal and estuarine habitats. Includes field, laboratory, and independent research project. Prereq: gen ecol; permission. Marine invert zool, oceanog, and statistics are desirable. 4 cr. (Not offered every year.)

### **808. STREAM ECOLOGY**

Ecological relationships of organisms in flowing water. Lectures on physical and chemical features of streams, floral and faunal communities, and factors controlling populations of benthic invertebrates. Streams as ecosystems. Laboratory exercises employ both field and laboratory experimental techniques. Occasional Saturday field trips. Weekly seminars on original research papers. 4 cr. (Not offered every year.)

### **811. FRESHWATER ZOOPLANKTON ECOLOGY**

Methods of sampling populations; factors regulating temporal and spacial distribution; trophic interactions of communities, role in nutrient cycle of lakes. Experimental techniques employed in field trips to freshwater habitats. Seminars examine current research. Prereq: gen ecol and limnology, Zool 717, or equivalent; permission. 4 cr. (Not offered every year.)

### **815. POPULATION ECOLOGY**

Dynamics of population growth; effects of age, structure, predation, and competition; measures of community interaction. Prereq: permission. Lab. 4 cr.

### **820, 821. ADVANCED INVERTEBRATE ZOOLOGY**

Morphology, phylogeny, and natural history of the major invertebrate phyla. Prereq: intro to invert zool or equivalent. 4 cr. (Not offered every year.)

### **822. PROTOZOОOLOGY**

General biology of protozoa; morphology, physiology, natural history, and economic importance. Prereq: Zool 721, 820, or permission. 4 cr. (Not offered every year.)

### **824. CONCEPTS AND TECHNIQUES IN REPRODUCTIVE BIOLOGY**

Investigations of the reproductive biology of invertebrate and vertebrate organisms, including gonad and gamete structure and function; generation, maintenance, and modulation of gametogenesis by environmental and hormonal factors; larval settlement and metamorphosis; and evolutionary significance and functional consequences of reproductive cycles in animals. Prereq: permission. 4 cr.

### **826. COMPARATIVE PHYSIOLOGY**

Nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prereq: Zool 723; permission. 4 cr. (Not offered every year.)

**895, 896. ADVANCED STUDIES IN**

**ZOOLOGY**

Course sections for advanced work, individual or group seminar. May include reading, laboratory work, organized seminars, and conferences. Prereq: permission of department chairperson and staff concerned. (Sections are the same as those listed under Zool 795, 796.) (Limit of 12 cr. from sections of this course.) 1-4 cr.

**897, 898. ZOOLOGY SEMINAR**

Reports on recent zoological literature. Subject fields are those listed under Zool 795, 796; not all areas available every semester. Required of graduate students in zoology. 0 cr. Cr/F.

**899. MASTER'S THESIS**

Prereq: permission of department chairperson and prospective supervisor. 6-10 cr.

**999. DOCTORAL RESEARCH**

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Concord, N.H. (1979-1983)

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Nashua, N.H. (1979-1983)

#### Barbara J. Seelye, Ph.D.

President, Keene State College  
Keene, N.H. (ex officio)

#### Stuart N. Shaines, B.S., M.B.A.

Dover, N.H. (1979-1983)

#### Gretchen Taylor, A.B.

Meriden, N.H. (1979-1985)

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# Faculty of the Graduate School

- Aikins, Janet** (1979)  
Assistant Professor of English; Ph.D., University of Chicago, 1980.
- Alexander, Lori A.** (1981)  
Assistant Professor of Physical Education; Ph.D., Ohio State University, 1980.
- Allmendinger, E. Eugene** (1958)  
Associate Professor of Naval Architecture and Director of Marine Operations; M.S., University of New Hampshire, 1950.
- Amell, Alexander R.** (1955)  
Professor of Chemistry; Ph.D., University of Wisconsin, 1950.
- Amsden, Katherine** (1967)  
Associate Professor of Physical Education; Ph.D., University of Southern California, 1967.
- Andersen, Kenneth K.** (1960)  
Professor of Chemistry; Ph.D., University of Minnesota, 1959.
- Anderson, Franz E.** (1967)  
Professor of Geology; Ph.D., University of Washington, 1967.
- Andrew, Michael D.** (1966)  
Associate Professor of Education; Ed.D., Harvard University, 1969.
- Andrews, Richard A.** (1959)  
Professor of Resource Economics; Ph.D., University of Minnesota, 1959.
- Annis, William H.** (1962)  
Professor of Occupational Education; Ed.D., Cornell University, 1961.
- Antonak, Richard F.** (1975)  
Associate Professor of Education; Ed.D., Temple University, 1975.
- Arnoldy, Roger L.** (1967)  
Professor of Physics; Ph.D., University of Minnesota, 1962.
- Ashley, Charles H.** (1969)  
Associate Professor of Education; Ed.D., Boston University, 1969.
- Azzi, Victor D.** (1979)  
Adjunct Professor of Civil Engineering; D. Eng., Yale University, 1961.
- Baker, Alan L.** (1972)  
Associate Professor of Botany; Ph.D., University of Minnesota, 1973.
- Balling, L. Christian** (1967)  
Professor of Physics; Ph.D., Harvard University, 1965.
- Balomenos, Richard H.** (1961)  
Professor of Mathematics Education; Ed.D., Harvard University, 1961.
- Barber, Richard W.** (1981)  
Assistant Professor of Business Administration; Ph.D., Harvard University, 1975.
- Barlow, Robert F.** (1962)  
Professor of Economics and Administration; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1960.
- Barrett, James P.** (1962)  
Professor of Forest Biometrics and Genetics; Ph.D., Duke University, 1962.
- Bauer, Christopher F.** (1981)  
Assistant Professor of Chemistry; Ph.D., Colorado State University, 1979.
- Baum, William M.** (1977)  
Associate Professor of Psychology; Ph.D., Harvard University, 1966.
- Beasley, Wayne M.** (1957)  
Associate Professor of Materials Science; S.M., Massachusetts Institute of Technology, 1965.
- Bechtell, Horner F., Jr.** (1966)  
Professor of Mathematics; Ph.D., University of Wisconsin, 1963.
- Bennett, Albert B., Jr.** (1967)  
Associate Professor of Mathematics; Ed.D., University of Michigan, 1966.
- Bergeron, R. Daniel** (1974)  
Associate Professor of Computer Science; Ph.D., Brown University, 1973.
- Berndtson, William E.** (1979)  
Assistant Professor of Animal Science; Ph.D., Cornell University, 1971.
- Birch, Francis S.** (1972)  
Associate Professor of Earth Sciences; Ph.D., Princeton University, 1969.
- Bishop, Paul L.** (1972)  
Professor of Civil Engineering; Ph.D., Purdue University, 1972.
- Blakemore, Richard P.** (1977)  
Associate Professor of Microbiology; Ph.D., University of Massachusetts, 1975.
- Blanchard, Fletcher, A., Jr.** (1950)  
Professor of Electrical Engineering; M.S., Lehigh University, 1950.
- Blanchard, Robert O.** (1972)  
Associate Professor of Plant Pathology; Ph.D., University of Georgia, 1971.
- Bobick, Melvin T.** (1958)  
Professor of Sociology; Ph.D., University of Illinois, 1958.
- Bogle, A. Linn** (1970)  
Associate Professor of Botany; Ph.D., University of Minnesota, 1968.
- Bolian, Charles** (1971)  
Associate Professor of Anthropology; Ph.D., University of Illinois, 1975.
- Bonnice, William E.** (1962)  
Associate Professor of Mathematics; Ph.D., University of Washington, 1962.
- Borrer, Arthur C.** (1961)  
Professor of Zoology; Ph.D., Florida State University, 1961.
- Bothner, Wallace A.** (1967)  
Professor of Geology; Ph.D., University of Wyoming, 1967.
- Bowman, James S.** (1971)  
Associate Professor of Entomology and Extension Entomologist; Ph.D., University of Wisconsin, 1958.
- Boy, Angelo V.** (1965)  
Professor of Education; Ed.D., Boston University, 1960.
- Boynton, Jason E.** (1966)  
Associate Professor of Education; M.Ed., University of New Hampshire, 1952.
- Braff, Allan J.** (1965)  
Associate Professor of Economics; Ph.D., University of Wisconsin, 1959.
- Broderick, Dale G.** (1974)  
Associate Professor of Business Administration; Ph.D., Columbia University, 1973.

- Brown, Warren R.** (1972)  
Associate Professor of Political Science; Ph.D., Claremont Graduate School, 1976.
- Brown, Wendell S.** (1974)  
Associate Professor of Earth Sciences; Ph.D., Massachusetts Institute of Technology, 1971.
- Bryce, Jennifer W.** (1981)  
Assistant Professor of Home Economics; Ed.D., Columbia University, 1980.
- Buckley, Walter F.** (1971)  
Professor of Sociology; Ph.D., University of Wisconsin, 1958.
- Bullock, Wilbur L.** (1948)  
Professor of Zoology; Ph.D., University of Illinois, 1948.
- Burger, John F.** (1977)  
Assistant Professor of Entomology; Ph.D., University of Arizona, 1971.
- Burt, John M., Jr.** (1974)  
Associate Professor of Administration; Ph.D., Carnegie-Mellon University, 1969.
- Burton, David M.** (1959)  
Professor of Mathematics; Ph.D., University of Rochester, 1961.
- Byers, Gordon L.** (1956)  
Professor of Soil and Water Science; M.S.A., Ontario Agricultural College, 1950.
- Cady, Roger A.** (1982)  
Assistant Professor of Animal Science; Ph.D., Cornell University, 1980.
- Calarco, John R.** (1981)  
Research Associate Professor of Physics; Ph.D., University of Illinois, 1969.
- Callan, Richard J.** (1969)  
Professor of Spanish; Ph.D., St. Louis University, 1965.
- Carney, John J.** (1973)  
Associate Professor of Education; Ph.D., Syracuse University, 1973.
- Carnicelli, Thomas A.** (1967)  
Professor of English; Ph.D., Harvard University, 1966.
- Carroll, John E.** (1974)  
Associate Professor of Environmental Conservation; Ph.D., Michigan State University, 1974.
- Carter, Gavin H.** (1965)  
Associate Professor of Physical Education; Ph.D., University of Oregon, 1958.
- Casás, R. Alberto** (1952)  
Professor of Spanish; Ph.D., Columbia University, 1954.
- Celikkol, Barbaros** (1969)  
Associate Professor of Mechanical Engineering; Ph.D., University of New Hampshire, 1972.
- Chaltas, John G.** (1967)  
Associate Professor of Education; Ed.D., Columbia University, 1957.
- Chandler, Donald S.** (1981)  
Assistant Professor of Entomology and Curator; Ph.D., Ohio State University, 1976.
- Chasteen, N. Dennis** (1972)  
Professor of Chemistry; Ph.D., University of Illinois, 1969.
- Chesbro, William R.** (1959)  
Professor of Microbiology; Ph.D., Illinois Institute of Technology, 1959.
- Chu, Yen-hsi** (1977)  
Assistant Professor of Civil Engineering; Sc.D., Massachusetts Institute of Technology, 1972.
- Chupp, Edward L.** (1962)  
Professor of Physics; Ph.D., University of California at Berkeley, 1954.
- Cioffi, Grant L.** (1980)  
Assistant Professor of Education; Ph.D., University of Minnesota, 1980.
- Clark, Charles E.** (1967)  
Professor of History; Ph.D., Brown University, 1966.
- Clark, Mary Morris** (1978)  
Assistant Professor of English; Ph.D., University of Massachusetts, 1978.
- Clark, Ronald R.** (1957)  
Professor of Electrical Engineering; Ph.D., Syracuse University, 1963.
- Cohen, Allan R.** (1967)  
Professor of Organizational Behavior; D.B.A., Harvard Graduate School of Business Administration, 1967.
- Cohn, Ellen S.** (1978)  
Assistant Professor of Psychology; Ph.D., Temple University, 1978.
- Collins, Walter M.** (1951)  
Professor of Animal Science and Genetics; Ph.D., Iowa State University, 1960.
- Condon, William C.** (1976)  
Associate Professor of Animal Science and Reproductive Physiologist; Ph.D., University of Massachusetts, 1975.
- Congdon, Robert G.** (1952)  
Adjunct Associate Professor of Psychology; Ed.D., Harvard University, 1961.
- Constantine, Kenneth B.** (1981)  
Assistant Professor of Mathematics; Ph.D., Purdue University, 1981.
- Conte, Michael A.** (1978)  
Assistant Professor of Economics; Ph.D., University of Michigan, 1979.
- Copeland, Arthur H., Jr.** (1968)  
Professor of Mathematics; Ph.D., Massachusetts Institute of Technology, 1954.
- Corcoran, Ellen P.** (1972)  
Associate Professor of Education; Ph.D., New York University, 1972.
- Corell, Robert W.** (1957–60, 1964)  
Director of UNH Marine Program, Director of Sea Grant Program, and Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1964.
- Craig, Robert E.** (1966)  
Associate Professor of Political Science; Ph.D., University of North Carolina, 1971.
- Croker, Robert A.** (1966)  
Professor of Zoology; Ph.D., Emory University, 1966.
- Crow, Garrett E.** (1975)  
Associate Professor of Botany; Ph.D., Michigan State University, 1974.
- Darr, Ginny W.** (1978)  
Assistant Professor of Animal Science; Ph.D., University of Colorado, 1975.
- Davis, James R.** (1970)  
Associate Professor of Psychology; Ph.D., University of Wisconsin, 1969.

- Davis, Robert I.** (1975)  
Adjunct Professor of Geology; Ph.D., University of Michigan, 1954.
- Dawson, Carl** (1970)  
Professor of English; Ph.D., Columbia University, 1966.
- Dawson, John F.** (1968)  
Professor of Physics; Ph.D., Stanford University, 1963.
- De Alba, Pedro A.** (1977)  
Associate Professor of Civil Engineering; Ph.D., University of California at Berkeley, 1975.
- Demeritt, Maurice E., Jr.** (1981)  
Adjunct Assistant Professor of Forest Genetics; Ph.D., Pennsylvania State University, 1972.
- DePorte, Michael V.** (1972)  
Professor of English; Ph.D., Stanford University, 1966.
- Diefendorf, Jeffry M.** (1976)  
Associate Professor of History; Ph.D., University of California at Berkeley, 1975.
- Diller, Ann L.** (1973)  
Associate Professor of Education; Ed.D., Harvard University, 1971.
- Diller, Karl C.** (1972)  
Professor of English; Ph.D., Harvard University, 1967.
- Dingman, S. Lawrence** (1975)  
Associate Professor of Water Resources; Ph.D., Harvard University, 1970.
- Dishman, Robert B.** (1951)  
Professor of Political Science; Ph.D., Princeton University, 1948.
- Dodge, Peter** (1964)  
Associate Professor of Sociology; Ph.D., Harvard University, 1961.
- Dolan, Elizabeth M.** (1980)  
Assistant Professor of Home Economics; Ph.D., Virginia Polytechnic Institute and State University, 1980.
- Downs, Richard E.** (1962)  
Associate Professor of Anthropology; Ph.D., University of Leiden, 1956.
- Draves, David D.** (1964)  
Associate Professor of Education; Ph.D., University of Wisconsin, 1957.
- Drew, William H.** (1956)  
Associate Dean of the Graduate School and Professor of Resource Economics; Ph.D., Vanderbilt University, 1961.
- Durgin, Owen B.** (1951)  
Professor of Resource Economics; M.A., University of New Hampshire, 1951.
- Durnall, Edward J.** (1966)  
Director of the Division of Continuing Education and Associate Professor of Education; Ed.D., Oregon State University, 1953.
- Durrell, Donald D.** (1973)  
Adjunct Professor of Education; Ed.D., Harvard University, 1930.
- East, Linda D.** (1979)  
Assistant Professor of Spanish; M.A., Stanford University, 1975.
- Eckert, Robert T.** (1978)  
Assistant Professor of Forest Genetics; Ph.D., Ohio State University, 1978.
- Edwards, Ruth S.** (1966)  
Associate Professor of Music; M.M., Northwestern University, 1950.
- Engalichev, Nicolas** (1963)  
Professor of Resource Economics and Extension Economist; M.S., State University of New York College of Forestry at Syracuse, 1960.
- England, Richard W.** (1976)  
Associate Professor of Economics; Ph.D., University of Michigan, 1974.
- Erickson, Raymond L.** (1963)  
Dean of the Graduate School, Associate Vice President for Academic Affairs, and Professor of Psychology; Ph.D., University of California at Los Angeles, 1962.
- Estes, George O.** (1969)  
Professor of Plant Science; Ph.D., Oregon State University, 1969.
- Etebari, Ahmad** (1980)  
Assistant Professor of Business Administration; Ph.D., North Texas State University, 1979.
- Fairchild, Thomas P.** (1969)  
Professor of Animal Science and Genetics and Extension Dairyman; Ph.D., University of Wisconsin, 1964.
- Fan, Stephen S. T.** (1962)  
Professor of Chemical Engineering; Ph.D., Stanford University, 1962.
- Farag, Ihab H.** (1976)  
Associate Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1976.
- Farber, Florence E.** (1981)  
Assistant Professor of Microbiology and Genetics; Ph.D., Columbia University, 1966.
- Federer, C. Anthony** (1970)  
Adjunct Associate Professor of Micrometeorology; Ph.D., University of Wisconsin, 1964.
- Feltner, Kurt C.** (1979)  
Dean of the College of Life Sciences and Agriculture, Director of the Agricultural Experiment Station, and Professor of Plant Science; Ph.D., University of Arizona, 1962.
- Fernald, Peter S.** (1966)  
Associate Professor of Psychology; Ph.D., Purdue University, 1963.
- Fink, Stephen L.** (1969)  
Professor of Organizational Behavior; Ph.D., Case Western Reserve University, 1959.
- Fisher, G. Thomas** (1969)  
Associate Professor of Entomology and Extension Entomologist; Ph.D., Rutgers University, 1954.
- Fisher, Lester A.** (1968)  
Assistant Professor of English; Ph.D., Brown University, 1976.
- Fisk, Lennard A., Jr.** (1977)  
Director of Research and Professor of Physics; Ph.D., University of California at San Diego, 1969.
- Forbes, F. William** (1970)  
Associate Professor of Spanish; Ph.D., University of Arizona, 1971.
- Foret, John E.** (1967)  
Associate Professor of Zoology; Ph.D., Princeton University, 1966.
- Francq, Edward N.** (1965)  
Associate Professor of Zoology; Ph.D., Pennsylvania State University, 1967.
- Franzosa, Susan D.** (1979)  
Assistant Professor of Education; Ph.D., State University of New York at Buffalo, 1979.

- Freuder, Eugene C.** (1977)  
Associate Professor of Computer Science; Ph.D., Massachusetts Institute of Technology, 1975.
- Frick, George E.** (1957)  
Adjunct Professor of Resource Economics; M.S., University of Connecticut, 1947.
- Frost, Albert D.** (1957)  
Professor of Electrical Engineering; Sc.D., Massachusetts Institute of Technology, 1952.
- Fuld, Kenneth** (1979)  
Assistant Professor of Psychology; Ph.D., Dartmouth College, 1976.
- Galvin, Maryanne** (1981)  
Assistant Professor of Education; Ed.D., University of Massachusetts, 1980.
- Garrett, Peter W.** (1970)  
Adjunct Assistant Professor of Forest Genetics; Ph.D., University of Michigan, 1969.
- Gaudard, Marie A.** (1977)  
Assistant Professor of Mathematics; Ph.D., University of Massachusetts, 1977.
- Gaudette, Henri E.** (1965)  
Professor of Geology; Ph.D., University of Illinois, 1963.
- Geeslin, William E.** (1972)  
Associate Professor of Mathematics; Ph.D., Stanford University, 1973.
- Gerhard, Glen C.** (1967)  
Associate Professor of Electrical Engineering; Ph.D., Ohio State University, 1963.
- Gill, Gregory D.** (1977)  
Assistant Professor of Occupational Education; Ph.D., Colorado State University, 1977.
- Gilmore, Robert C.** (1952)  
Professor of History; Ph.D., Yale University, 1954.
- Glanz, Filson H.** (1965)  
Associate Professor of Electrical Engineering; Ph.D., Stanford University, 1965.
- Goodman, Richard H.** (1976)  
Adjunct Associate Professor of Education; Ed.D., Harvard University, 1961.
- Goodspeed, Charles H.** (1978)  
Associate Professor of Civil Engineering; Ph.D., University of Cincinnati, 1972.
- Gordon, Bernard K.** (1971)  
Professor of Political Science; Ph.D., University of Chicago, 1959.
- Grant, Clarence L.** (1961)  
Professor of Chemistry; Ph.D., Rutgers University, 1960.
- Graulich, Melody** (1978)  
Assistant Professor of English; Ph.D., University of Virginia, 1979.
- Graves, Donald H.** (1973)  
Professor of Education; Ed.D., State University of New York at Buffalo, 1973.
- Green, Donald M.** (1967)  
Professor of Biochemistry and Genetics; Ph.D., University of Rochester, 1958.
- Greenwood, Peter H.** (1977)  
Assistant Professor of Resource Economics; Ph.D., Brown University, 1974.
- Gress, David L.** (1974)  
Associate Professor of Civil Engineering; Ph.D., Purdue University, 1976.
- Haaland, Gordon A.** (1965–74, 1979)  
Vice President for Academic Affairs and Professor of Psychology; Ph.D., State University of New York at Buffalo, 1966.
- Hadwin, Donald W.** (1977)  
Associate Professor of Mathematics; Ph.D., Indiana University, 1975.
- Hageman, Elizabeth** (1971)  
Associate Professor of English; Ph.D., University of North Carolina, 1971.
- Hagstrom, Earl C.** (1965)  
Associate Professor of Psychology; Ph.D., Brown University, 1957.
- Haley, Russell** (1975)  
Professor of Administration; Ph.D., Union Graduate School, 1974.
- Hall, Francine S.** (1980)  
Assistant Professor of Business Administration; Ph.D., University of Toronto, 1975.
- Hall, Francis R.** (1964)  
Professor of Hydrology; Ph.D., Stanford University, 1961.
- Hamilton, Lawrence C.** (1977)  
Assistant Professor of Sociology; Ph.D., University of Colorado, 1978.
- Handler, Evelyn E.** (1980)  
President and Professor of Zoology; Ph.D., New York University, 1963.
- Haney, James F.** (1972)  
Associate Professor of Zoology; Ph.D., University of Toronto, 1970.
- Hansen, Jane A.** (1979)  
Assistant Professor of Education; Ph.D., University of Minnesota, 1979.
- Hansen, Larry J.** (1973)  
Associate Professor of Home Economics; Ph.D., Florida State University, 1973.
- Hapgood, Robert** (1965)  
Professor of English; Ph.D., University of California, 1955.
- Harel, Dov** (1980)  
Assistant Professor of Computer Science; Ph.D., University of California at Irvine, 1980.
- Harrington, Barry J.** (1975)  
Associate Professor of Physics; Ph.D., Harvard University, 1975.
- Harris, Larry G.** (1969)  
Associate Professor of Zoology; Ph.D., University of California, 1970.
- Harter, Robert D.** (1969)  
Associate Professor of Soil Chemistry; Ph.D., Purdue University, 1966.
- Hebert, David J.** (1967)  
Associate Professor of Education; Ph.D., Kent State University, 1967.
- Heckel, Maynard C.** (1971)  
Associate Dean of the College of Life Sciences and Agriculture, Director of Cooperative Extension, and Professor of Adult Education; Ed.D., Cornell University, 1961.
- Heilbronner, Hans** (1954)  
Professor of History; Ph.D., University of Michigan, 1954.
- Heisenberg, Jochen** (1978)  
Professor of Physics; Doctor, University of Hamburg, 1966.

- Heiser, John B.** (1980)  
Director of Shoals Marine Laboratory and Adjunct Assistant Professor of Zoology; Ph.D., Cornell University, 1979.
- Henry, Robert M.** (1980)  
Assistant Professor of Civil Engineering; Ph.D., University of Pennsylvania, 1980.
- Herbst, Edward J.** (1962)  
Professor of Biochemistry; Ph.D., University of Wisconsin, 1949.
- Herold, Marc W.** (1975)  
Associate Professor of Economics; Ph.D., University of California at Berkeley, 1977.
- Hettinger, Stanley D.** (1965)  
Associate Professor of Music and Band Director; M.M.E., Vander-Cook College, 1966.
- Hill, John L.** (1964)  
Professor of Wood Science and Technology; D.F., Yale University, 1954.
- Hochgraf, Frederick G.** (1958)  
Associate Professor of Materials Science; M.S., Cornell University, 1958.
- Hocker, Harold W., Jr.** (1955)  
Professor of Forest Resources and Genetics; D.F., Duke University, 1955.
- Hoff, Phyllis A.** (1967)  
Associate Professor of Physical Education; Ph.D., University of Southern California, 1967.
- Hollweg, Joseph V.** (1980)  
Research Associate Professor of Physics; Ph.D., Massachusetts Institute of Technology, 1968.
- Holter, James B.** (1963)  
Professor of Animal Science; Ph.D., Pennsylvania State University, 1962.
- Hoornbeek, Frank K.** (1964)  
Professor of Zoology and Genetics; Ph.D., Oregon State University, 1964.
- Hornbeck, James W.** (1979)  
Adjunct Associate Professor of Forest Hydrology; Ph.D., State University of New York College of Environmental Science and Forestry at Syracuse, 1973.
- Horigan, James O.** (1966)  
Forbes Professor of Business Administration; Ph.D., University of Chicago, 1967.
- Houston, Robert E., Jr.** (1957)  
Professor of Physics; Ph.D., Pennsylvania State University, 1957.
- Howard, Cleveland L.** (1969)  
Associate Professor of Music; D.M.A., Boston University, 1969.
- Howard, Theodore E.** (1981)  
Assistant Professor of Forest Economics; Ph.D., Oregon State University, 1981.
- Howell, W. Huntting,** (1980)  
Assistant Professor of Zoology; Ph.D., University of Rhode Island, 1980.
- Hoyle, Merrill C.** (1972)  
Adjunct Assistant Professor of Plant Science; Ph.D., University of New Hampshire, 1971.
- Hubbard, Colin D.** (1967)  
Professor of Chemistry; Ph.D., University of Sheffield, 1964.
- Hurd, Richard W.** (1973)  
Associate Professor of Economics; Ph.D., Vanderbilt University, 1972.
- Hylton, Walter E.** (1976)  
Associate Professor of Animal Science; V.M.D., University of Pennsylvania, 1970.
- Ikawa, Miyoshi** (1963)  
Professor of Biochemistry; Ph.D., University of Wisconsin, 1948.
- Irish, James D.** (1979)  
Research Associate Professor of Earth Sciences; Ph.D., University of California at San Diego, 1971.
- Irwin, Manley R.** (1963)  
Professor of Economics; Ph.D., Michigan State University, 1963.
- Jacoby, A. Robb** (1961)  
Professor of Mathematics; Ph.D., University of Chicago, 1946.
- Jahnke, Leland S.** (1977)  
Associate Professor of Botany; Ph.D., University of Minnesota, 1973.
- James, Marion E.** (1955)  
Associate Professor of History; Ph.D., Harvard University, 1955.
- Jansen, Edmund F., Jr.** (1969)  
Professor of Resource Economics; Ph.D., North Carolina State University, 1966.
- Janson, Colette H.** (1981)  
Assistant Professor of Home Economics; Ph.D., University of New Hampshire, 1980.
- Jaworski, Gary W.** (1979)  
Assistant Professor of Civil Engineering; Ph.D., University of California at Berkeley, 1979.
- Jellison, Charles A., Jr.** (1956)  
Professor of History; Ph.D., University of Virginia, 1956.
- Johnson, Paul C.** (1979)  
Assistant Professor of Entomology; Ph.D., Cornell University, 1974.
- Jones, Galen E.** (1966)  
Professor of Microbiology; Ph.D., Rutgers University, 1956.
- Jones, Paul R.** (1956)  
Professor of Chemistry; Ph.D., University of Illinois, 1956.
- Jones, William R.** (1962)  
Professor of History; Ph.D., Harvard University, 1958.
- Kaen, Fred R.** (1973)  
Associate Professor of Finance; Ph.D., University of Michigan, 1972.
- Kalinowski, Michael F.** (1980)  
Assistant Professor of Home Economics; Ed.D., University of Massachusetts, 1976.
- Kaufmann, Richard L.** (1963)  
Professor of Physics; Ph.D., Yale University, 1960.
- Kayser, John R.** (1969)  
Associate Professor of Political Science; Ph.D., Claremont Graduate School and University Center, 1969.
- Kennard, Jean E.** (1975)  
Professor of English; Ph.D., University of California at Berkeley, 1968.
- Kertzer, Robert** (1965)  
Associate Professor of Physical Education; Ph.D., Michigan State University, 1965.
- Khleif, Bud B.** (1967)  
Professor of Sociology; Ph.D., Johns Hopkins University, 1957.

- Kiang, Yun-Tzu** (1970)  
Associate Professor of Plant Science and Genetics; Ph.D., University of California at Berkeley, 1970.
- Kimball, Roland B.** (1963)  
Professor of Education; Ed.D., Harvard University, 1958.
- Klotz, Louis H.** (1965)  
Associate Professor of Civil Engineering; Ph.D., Rutgers University, 1967.
- Koch, David W.** (1971)  
Associate Professor of Plant Science; Ph.D., Colorado State University, 1971.
- Kole, Michael** (1977)  
Assistant Professor of Business Administration; Ph.D., University of Massachusetts, 1978.
- Komonchak, Bernadette** (1976)  
Assistant Professor of Spanish; Ph.D., University of Arizona, 1974.
- Korbel, John J.** (1966)  
Professor of Economics and Business Administration; Ph.D., Harvard University, 1959.
- Kraft, L. Gordon** (1978)  
Assistant Professor of Electrical Engineering; Ph.D., University of Connecticut, 1977.
- Kuo, Shan S.** (1964)  
Professor of Computer Science; D. Eng., Yale University, 1958.
- LaBay, Duncan** (1980)  
Assistant Professor of Business Administration; Ph.D., University of Michigan, 1979.
- LaCourse, John R.** (1980)  
Assistant Professor of Electrical Engineering; Ph.D., University of Connecticut, 1981.
- Ladd, Dwight R.** (1964)  
Dean of the Whitemore School of Business and Economics and Professor of Business Administration; D.B.A., Harvard University, 1956.
- Laird, Jo** (1979)  
Assistant Professor of Geology; Ph.D., California Institute of Technology, 1977.
- Lamb, Richard** (1980)  
Assistant Professor of Business Administration; M.B.A., Suffolk University, 1971.
- Lambert, Robert H.** (1955-56, 1961)  
Professor of Physics; Ph.D., Harvard University, 1963.
- Larson, Barbara K.** (1976)  
Assistant Professor of Anthropology; Ph.D., Columbia University, 1975.
- Larson, David L.** (1965)  
Associate Professor of Political Science; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1963.
- Latta, R. Michael** (1978)  
Assistant Professor of Psychology; Ph.D., Iowa State University, 1976.
- Lavoie, Marcel E.** (1950-52, 1955)  
Associate Professor of Zoology; Ph.D., Syracuse University, 1956.
- LeRay, Nelson L., Jr.** (1966)  
Adjunct Professor of Resource Economics; Ed.D., Cornell University, 1965.
- Leak, William B.** (1967)  
Adjunct Associate Professor of Forest Resources; M.F., Syracuse University, 1956.
- Leary, David E.** (1976)  
Associate Professor of Psychology; Ph.D., University of Chicago, 1977.
- Lee, Thomas D.** (1980)  
Assistant Professor of Botany; Ph.D., University of Illinois at Urbana, 1980.
- Leighton, Charles H.** (1956)  
Professor of Spanish; Ph.D., Harvard University, 1961.
- Lewis, Frederick, C.** (1976)  
Associate Professor of Communication Disorders; Ph.D., Ohio University, 1970.
- Lieber, Rochelle** (1981)  
Assistant Professor of English; Ph.D., Massachusetts Institute of Technology, 1980.
- Limber, John E.** (1971)  
Associate Professor of Psychology; Ph.D., University of Illinois at Urbana, 1969.
- Limbert, David E.** (1969)  
Associate Professor of Mechanical Engineering; Ph.D., Case Western Reserve University, 1969.
- Lindberg, Gary H.** (1974)  
Professor of English; Ph.D., Stanford University, 1967.
- Linden, Allen B.** (1963)  
Associate Professor of History; Ph.D., Columbia University, 1969.
- Lindsay, Bruce E.** (1976)  
Associate Professor of Resource Economics; Ph.D., University of Massachusetts, 1976.
- Linsky, Arnold S.** (1966)  
Professor of Sociology; Ph.D., University of Washington, 1966.
- Lockwood, John A.** (1948)  
Professor of Physics; Ph.D., Yale University, 1948.
- Loder, Theodore C., III** (1972)  
Associate Professor of Earth Sciences; Ph.D., University of Alaska, 1971.
- Logan, Terence P.** (1968)  
Professor of English; Ph.D., Harvard University, 1966.
- Long, David F.** (1948)  
Professor of History; Ph.D., Columbia University, 1950.
- Loy, J. Brent** (1967)  
Professor of Plant Science and Genetics; Ph.D., Colorado State University, 1967.
- Luloff, Albert E.** (1977)  
Associate Professor of Community Development; Ph.D., Pennsylvania State University, 1977.
- Lyons, Harvey** (1981)  
Associate Professor of Mechanical Engineering; Ph.D., Ohio State University, 1978.
- Lyons, Wm. Berry** (1980)  
Assistant Professor of Earth Sciences; Ph.D., University of Connecticut, 1979.
- MacHardy, William E.** (1972)  
Associate Professor of Plant Pathology and Extension Plant Pathologist; Ph.D., University of Rhode Island, 1970.
- Mallory, Bruce L.** (1979)  
Assistant Professor of Education; Ph.D., George Peabody College, 1979.
- Martin, Charles W.** (1978)  
Assistant Professor of Communication Disorders; Ph.D., Southern Illinois University, 1975.
- Martin-Diaz, Richard** (1979)  
Associate Professor of Administration; Ph.D., Syracuse University, 1976.

- Mathieson, Arthur C.** (1965)  
Director of the Jackson Estuarine Laboratory and Professor of Botany; Ph.D., University of British Columbia, 1965.
- Mathur, Virendra K.** (1974)  
Associate Professor of Chemical Engineering; Ph.D., University of Missouri at Rolla, 1970.
- Mautz, William W.** (1969)  
Professor of Wildlife Ecology; Ph.D., Michigan State University, 1969.
- Mayewski, Paul A.** (1974)  
Associate Professor of Earth Sciences; Ph.D., Ohio State University, 1973.
- Mazza, Karen A.** (1980)  
Assistant Professor of Education; Ed.D., Boston University, 1980.
- McBride, Mekeel** (1979)  
Assistant Professor of English; B.A., Mills College, 1972.
- McCann, Francis D., Jr.** (1971)  
Professor of History; Ph.D., Indiana University, 1967.
- McKeough, D. Michael** (1977)  
Assistant Professor of Physical Education; Ed.D., Teachers College, Columbia University, 1977.
- Mebert, Carolyn J.** (1979)  
Assistant Professor of Psychology; Ph.D., Boston University, 1979.
- Meeker, Loren D.** (1970)  
Professor of Mathematics; Ph.D., Stanford University, 1965.
- Melvin, Donald W.** (1957)  
Associate Dean of the College of Engineering and Physical Sciences and Associate Professor of Electrical Engineering; Ph.D., Syracuse University, 1971.
- Menge, Carleton P.** (1948)  
Professor of Education; Ph.D., University of Chicago, 1948.
- Mennel, Robert M.** (1969)  
Professor of History; Ph.D., Ohio State University, 1969.
- Merenda, Michael J.** (1977)  
Assistant Professor of Administration; Ph.D., University of Massachusetts, 1978.
- Merton, Andrew H.** (1972)  
Associate Professor of English; B.A., University of New Hampshire, 1967.
- Messier, Victor R.** (1970)  
Associate Professor of Home Economics; Ph.D., Pennsylvania State University, 1973.
- Miller, Donald R.** (1977)  
Assistant Professor of Wildlife Ecology; Ph.D., University of Idaho, 1976.
- Miller, Edmund G.** (1951)  
Professor of English; Ph.D., Columbia University, 1955.
- Miller, Walter T., III** (1979)  
Assistant Professor of Electrical Engineering; Ph.D., Pennsylvania State University, 1977.
- Mills, Richard L.** (1967)  
Associate Professor of Economics and Business Administration; Ph.D., Indiana University, 1967.
- Minocha, Subhash C.** (1974)  
Associate Professor of Botany and Genetics; Ph.D., University of Washington, 1974.
- Mitchell, James R.** (1963)  
Associate Professor of Plant Science and Extension Agronomist, Forage Crops; Ph.D., Pennsylvania State University, 1969.
- Moore, David W.** (1972)  
Associate Professor of Political Science; Ph.D., Ohio State University, 1970.
- Morrison, James D.** (1965)  
Professor of Chemistry; Ph.D., Northwestern University, 1963.
- Mosberg, William** (1958)  
Associate Professor of Mechanical Engineering; M.Eng., Yale University, 1960.
- Mott, Basil J. F.** (1973)  
Dean of the School of Health Studies and Professor of Health Administration and Planning; Ph.D., Harvard University, 1967.
- Mower, Lyman** (1957)  
Professor of Physics; Ph.D., Massachusetts Institute of Technology, 1953.
- Mulhern, John E., Jr.** (1954)  
Professor of Physics; Ph.D., Boston University, 1954.
- Murdoch, Joseph B.** (1952)  
Professor of Electrical Engineering; Ph.D., Case Institute of Technology, 1962.
- Murray, Donald M.** (1963)  
Professor of English; B.A., University of New Hampshire, 1948.
- Murray, Frederick P.** (1966)  
Associate Professor of Communication Disorders; Ph.D., University of Denver, 1966.
- Nahin, Paul J.** (1975)  
Associate Professor of Electrical Engineering; Ph.D., University of California at Irvine, 1972.
- Nevin, John A.** (1972)  
Professor of Psychology; Ph.D., Columbia University, 1963.
- Newkirk, Thomas R.** (1977)  
Assistant Professor of English; Ph.D., University of Texas, 1977.
- Nicoloff, Philip L.** (1954)  
Professor of English; Ph.D., Columbia University, 1959.
- Nielson, Melville** (1950)  
Associate Dean of the College of Liberal Arts and Associate Professor of Sociology; Ph.D., Ohio State University, 1955.
- Nordgren, Eric A.** (1964)  
Professor of Mathematics; Ph.D., University of Michigan, 1964.
- O'Connell, Lawrence W.** (1966)  
Associate Professor of Political Science; Ph.D., Syracuse University, 1968.
- Oja, Sharon N.** (1977)  
Associate Professor of Education; Ph.D., University of Minnesota, 1978.
- Olson, David P.** (1968)  
Professor of Wildlife Management; Ph.D., University of Minnesota, 1964.
- Ossenbruggen, Paul J.** (1975)  
Associate Professor of Civil Engineering; Ph.D., Carnegie-Mellon University, 1970.
- Owens, Charles W.** (1963)  
Professor of Chemistry; Ph.D., University of Kansas, 1963.

- Palmer, Stuart H.** (1955)  
Dean of the College of Liberal Arts and Professor of Sociology; Ph.D., Yale University, 1955.
- Parsons, Alan H.** (1979)  
Assistant Professor of Animal Science; Ph.D., Cornell University, 1980.
- Peirce, Lincoln C.** (1964)  
Professor of Plant Science and Genetics; Ph.D., University of Minnesota, 1958.
- Peterson, Nobel K.** (1957)  
Associate Professor of Soil and Water Science; Ph.D., Rutgers University, 1957.
- Pierce, Robert S.** (1967)  
Adjunct Professor of Forestry and Soil and Water Science; Ph.D., University of Wisconsin, 1957.
- Pilar, Frank L.** (1957)  
Professor of Chemistry; Ph.D., University of Cincinnati, 1957.
- Pilgrim, Sidney A. L.** (1979)  
Adjunct Associate Professor of Soil Sciences; B.S., University of New Hampshire, 1955.
- Pistole, Thomas G.** (1971)  
Associate Professor of Microbiology; Ph.D., University of Utah, 1969.
- Pokoski, John L.** (1967)  
Professor of Electrical Engineering; Ph.D., Montana State University, 1967.
- Polasky, Janet L.** (1981)  
Assistant Professor of History; Ph.D., Stanford University, 1978.
- Polk, Keith** (1964)  
Professor of Music; Ph.D., University of California at Berkeley, 1968.
- Poll, Solomon** (1964)  
Professor of Sociology; Ph.D., University of Pennsylvania, 1960.
- Pollard, James E.** (1970)  
Associate Professor of Plant Science; Ph.D., University of Florida, 1969.
- Potter, Hugh M., III** (1962)  
Associate Professor of English; Ph.D., University of Minnesota, 1965.
- Power, Marilyn B.** (1979)  
Assistant Professor of Economics; Ph.D., University of California at Berkeley, 1977.
- Puth, Robert C.** (1967)  
Associate Professor of Economics; Ph.D., Northwestern University, 1967.
- Radlow, James** (1965)  
Professor of Applied Mathematics; Ph.D., New York University, 1957.
- Rasmussen, Mary H.** (1968)  
Associate Professor of Music; M.M., University of Illinois, 1953.
- Reeves, R. Marcel** (1964)  
Associate Professor of Entomology and Forest Resources; Ph.D., State University of New York College of Environmental Science and Forestry at Syracuse, 1964.
- Reyna, Stephen P.** (1973)  
Associate Professor of Anthropology; Ph.D., Columbia University, 1972.
- Richardson, John C.** (1946)  
Professor of English; Ph.D., Boston University, 1959.
- Roberts, Betty H.** (1974)  
Adjunct Associate Professor of Resource Economics; Ph.D., Brandeis University, 1975.
- Roberts, John M.** (1979)  
Assistant Professor of Plant Science and Extension Horticulturist, Turf; Ph.D., Purdue University, 1977.
- Roberts, Lewis, Jr.** (1972)  
Director of Thompson School of Applied Science and Associate Professor of Occupational Education; Ed.D., Auburn University, 1972.
- Rogers, John E.** (1967)  
Associate Professor of Music; M.F.A., Princeton University, 1966.
- Rogers, Owen M.** (1959)  
Professor of Plant Science and Genetics; Ph.D., Pennsylvania State University, 1959.
- Romoser, George K.** (1961–62, 1967)  
Professor of Political Science; Ph.D., University of Chicago, 1958.
- Rosen, Sam** (1957)  
Nashua Corporation Professor of Economics; Ph.D., Harvard University, 1952.
- Ross, Shepley L.** (1955)  
Professor of Mathematics; Ph.D., Boston University, 1953.
- Rotwell, Kenneth J.** (1963)  
Professor of Economics; Ph.D., Harvard University, 1960.
- Routley, Douglas G.** (1957)  
Professor of Plant Science; Ph.D., Pennsylvania State University, 1957.
- Rudd, Joel** (1980)  
Assistant Professor of Home Economics; Ph.D., University of Iowa, 1979.
- Russell, Robert D.** (1975)  
Associate Professor of Computer Science; Ph.D., Stanford University, 1972.
- Rutman, Garrett B.** (1968)  
Professor of History; Ph.D., University of Virginia, 1959.
- Safford, Lawrence O.** (1981)  
Adjunct Associate Professor of Forestry; Ph.D., University of Maine, 1980.
- Samuels, Fred** (1966)  
Associate Professor of Sociology; Ph.D., University of Massachusetts, 1966.
- Sandler, Melvin** (1970)  
Associate Professor of Hotel Administration; M.A., Northwestern University, 1947; C.P.A.
- Sasner, John J., Jr.** (1965)  
Professor of Zoology; Ph.D., University of California at Los Angeles, 1965.
- Savage, Godfrey H.** (1965)  
Professor of Mechanical Engineering; Ph.D., Stanford University, 1970.
- Sawyer, Albert K.** (1949)  
Professor of Chemistry; M.S., University of Maine, 1947.
- Sawyer, Philip J.** (1952)  
Professor of Zoology; Ph.D., University of Michigan, 1956.
- Schibanoff, Susan** (1971)  
Associate Professor of English; Ph.D., University of California at Los Angeles, 1971.

- Schlobohm, Starr** (1975)  
Associate Professor of Business Administration; Ph.D., New York University, 1980.
- Schneer, Cecil J.** (1950, 1954)  
Professor of Geology and the History of Science; Ph.D., Cornell University, 1954.
- Schreiber, Richard W.** (1957)  
Professor of Botany; Ph.D., University of Wisconsin, 1955.
- Schwab, Charles** (1975)  
Associate Professor of Animal Science; Ph.D., University of Wisconsin, 1974.
- Schwab, Richard L.** (1980)  
Assistant Professor of Education; Ph.D., University of Connecticut, 1980.
- Schwarz, Marc L.** (1967)  
Associate Professor of History; Ph.D., University of California at Los Angeles, 1965.
- Schweickart, Patrocinio** (1979)  
Assistant Professor of English; Ph.D., Ohio State University, 1979.
- Seitz, W. Rudolf** (1976)  
Associate Professor of Chemistry; Ph.D., Massachusetts Institute of Technology, 1970.
- Shapiro, Howard M.** (1969)  
Associate Professor of Sociology; Ph.D., University of Minnesota, 1969.
- Shar, Albert O.** (1971)  
Executive Director of Computer Services and Professor of Mathematics; Ph.D., University of Pennsylvania, 1970.
- Shepard, Harvey K.** (1969)  
Professor of Physics; Ph.D., California Institute of Technology, 1966.
- Shigo, Alex L.** (1966)  
Adjunct Professor of Plant Pathology; Ph.D., West Virginia University, 1959.
- Shore, Barry** (1974)  
Professor of Administration; Ph.D., University of Wisconsin, 1968.
- Shore, Samuel D.** (1965)  
Associate Professor of Mathematics; Ph.D., Pennsylvania State University, 1964.
- Shortle, Walter C.** (1976)  
Adjunct Assistant Professor of Botany; Ph.D., North Carolina State University, 1974.
- Siddall, David V.** (1965)  
Assistant Professor of English; Ph.D., Indiana University, 1970.
- Silverman, Robert J.** (1962)  
Professor of Mathematics; Ph.D., University of Illinois, 1952.
- Simic, Charles D.** (1973)  
Professor of English; B.A., New York University, 1967.
- Simos, Evangelos O.** (1977)  
Assistant Professor of Economics; Ph.D., Northern Illinois University, 1977.
- Simpson, Robert E.** (1963)  
Associate Professor of Physics; Ph.D., Harvard University, 1960.
- Sir, W. Niel** (1970)  
Associate Professor of Music; M.A., University of California at Berkeley, 1962.
- Sitkoff, Harvard** (1976)  
Associate Professor of History; Ph.D., Columbia University, 1975.
- Sivaprasad, Kondagunta** (1969)  
Associate Professor of Electrical Engineering; Ph.D., Harvard University, 1963.
- Smith, James A.** (1972)  
Associate Dean of the College of Liberal Arts and Adjunct Associate Professor of Economics; Ph.D., Washington State University, 1967.
- Smith, M. Daniel** (1967)  
Associate Professor of Education; Ed.D., Harvard University, 1961.
- Smith, Mark R.** (1966)  
Professor of English; B.A., Northwestern University, 1960.
- Smith, Samuel C.** (1961)  
Professor of Animal Science and Biochemistry; Ph.D., Pennsylvania State University, 1962.
- Snell, Elizabeth A.** (1971)  
Associate Professor of Home Economics; Ph.D., Cornell University, 1971.
- Sprague, Linda G.** (1969)  
Professor of Business Administration; D. B. A., Harvard University, 1973.
- Sproul, Otis J.** (1982)  
Dean of the College of Engineering and Physical Sciences and Professor of Civil Engineering; Sc.D., Washington University, 1961.
- Stewart, James A.** (1968)  
Professor of Biochemistry; Ph.D., University of Connecticut, 1967.
- Stone, Deborah E.** (1962)  
Associate Professor of Education; Ed.D., Boston University, 1971.
- Straus, Murray A.** (1968)  
Professor of Sociology; Ph.D., University of Wisconsin, 1956.
- Strout, Richard G.** (1954)  
Professor of Animal Science; Ph.D., University of New Hampshire, 1961.
- Sundberg, Donald C.** (1978)  
Associate Professor of Chemical Engineering; Ph.D., University of Delaware, 1970.
- Sung, Windsor** (1980)  
Assistant Professor of Civil Engineering; Ph.D., California Institute of Technology, 1980.
- Swift, M. Robinson** (1976)  
Associate Professor of Mechanical Engineering; Ph.D., University of New Hampshire, 1974.
- Taft, Charles K.** (1967)  
Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1960.
- Tagliaferro, Anthony R.** (1978)  
Assistant Professor of Home Economics; Ph.D., Cornell University, 1978.
- Taylor, James T.** (1977)  
Assistant Professor of Zoology; Ph.D., Oregon State University, 1976.
- Thewke, Siegfried E.** (1979)  
Adjunct Assistant Professor of Entomology and State Entomologist; Ph.D., University of Missouri, 1977.
- Thompson, Allen R.** (1974)  
Associate Professor of Economics; Ph.D., University of Texas at Austin, 1973.

- Thompson, Henry J.** (1979)  
Associate Professor of Home Economics; Ph.D., Rutgers University, 1975.
- Tillinghast, Edward K.** (1967)  
Associate Professor of Zoology; Ph.D., Duke University, 1966.
- Tischler, Herbert** (1965)  
Professor of Geology; Ph.D., University of Michigan, 1961.
- Tokay, F. Harry** (1973)  
Associate Professor of Communication Disorders; Ph.D., Michigan State University, 1967.
- Trout, B. Thomas** (1969)  
Associate Professor of Political Science; Ph.D., Indiana University, 1972.
- Tucker, Charles F.** (1979)  
Adjunct Associate Professor of Law; J.D., Yale Law School, 1966.
- Ulrich, Gail D.** (1970)  
Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1964.
- Urban, Willard E., Jr.** (1963)  
Associate Professor of Biometrics and Genetics; Associate Director, Agricultural Experiment Station; Ph.D., Iowa State University, 1963.
- Valentine, Russell L.** (1953)  
Professor of Mechanical Engineering; M.S.M.E., Purdue University, 1954.
- Van Osdol, Donovan H.** (1970)  
Professor of Mathematics; Ph.D., University of Illinois, 1969.
- Verrette, Paul F.** (1962)  
Associate Professor of Music; M.A., Boston University, 1971.
- Vincent, Donald E.** (1962)  
Professor and University Librarian; Ph.D., University of Michigan, 1974.
- Voll, John O.** (1965)  
Professor of History; Ph.D., Harvard University, 1969.
- Walker, Charles W.** (1976)  
Associate Professor of Zoology; Ph.D., Cornell University, 1976.
- Wang, Tung-Ming** (1961)  
Professor of Civil Engineering; Ph.D., Northwestern University, 1960.
- Ward, Sally K.** (1980)  
Assistant Professor of Sociology; Ph.D., Brown University, 1977.
- Warner, Rebecca M.** (1981)  
Assistant Professor of Psychology; Ph.D., Harvard University, 1978.
- Warren, Jerry A.** (1971)  
Associate Professor of Plant Science; Ph.D., Cornell University, 1960.
- Waterfield, D. Allan** (1970)  
Associate Professor of Physical Education; Ph.D., Ohio State University, 1976.
- Watson, Winsor H., III** (1978)  
Assistant Professor of Zoology; Ph.D., University of Massachusetts, 1978.
- Watters, David H.** (1978)  
Assistant Professor of English; Ph.D., Brown University, 1978.
- Wear, Robert E.** (1964)  
Associate Professor of Physical Education; Ph.D., University of Michigan, 1955.
- Weathersby, Rita** (1978)  
Assistant Professor of Administration; Ed. D., Harvard University, 1977.
- Webb, Dwight** (1967)  
Associate Professor of Education; Ph.D., Stanford University, 1967.
- Webber, William R.** (1969)  
Professor of Physics; Ph.D., University of Iowa, 1957.
- Weber, James H.** (1963)  
Professor of Chemistry; Ph.D., Ohio State University, 1963.
- Weiland, Walter E.** (1964)  
Associate Professor of Physical Education; Ph.D., Pennsylvania State University, 1964.
- Weiner, James L.** (1979)  
Assistant Professor of Computer Science; Ph.D., University of California at Los Angeles, 1979.
- Weisman, Gary R.** (1977)  
Assistant Professor of Chemistry; Ph.D., University of Wisconsin, 1976.
- Wells, Otho S.** (1966)  
Associate Professor of Plant Science and Extension Horticulturist, Vegetables; Ph.D., Rutgers University, 1966.
- Wells, Roger E.** (1981)  
Assistant Professor of Animal Science; D.V.M., Ohio State University, 1972.
- Wetzel, William E., Jr.** (1967)  
Professor of Business Administration; M.B.A., University of Chicago, 1967.
- Weyrick, Richard R.** (1970)  
Associate Professor of Forest Resources; Ph.D., University of Minnesota, 1968.
- Wheeler, Charles M., Jr.** (1950)  
Professor of Chemistry; Ph.D., West Virginia University, 1951.
- Wheeler, Douglas L.** (1965)  
Professor of History; Ph.D., Boston University, 1963.
- White, Susan O.** (1969)  
Associate Professor of Political Science; Ph.D., University of Minnesota, 1970.
- Wicks, John D.** (1956)  
Professor of Music; Ph.D., Harvard University, 1959.
- Wilcox, Donald J.** (1970)  
Professor of History; Ph.D., Harvard University, 1967.
- Williams, Daniel C.** (1970)  
Associate Professor of Psychology; Ph.D., University of California at Santa Barbara, 1970.
- Williams, Thomas A., Jr.** (1958)  
Professor of English; M.A., University of New Hampshire, 1958.
- Willits, Robin D.** (1965)  
Professor of Administration and Organization; Ph.D., Massachusetts Institute of Technology, 1965.
- Wilson, John A.** (1960)  
Associate Professor of Mechanical Engineering; Ph.D., Northeastern University, 1970.
- Wing, Barbara H.** (1970)  
Assistant Professor of Spanish; Ph.D., Ohio State University, 1980.
- Wing, Henry J., Jr.** (1970)  
Associate Professor of Music; Ph.D., Boston University, 1966.
- Winn, Alden L.** (1948)  
Professor of Electrical Engineering; S.M., Massachusetts Institute of Technology, 1948.

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Assistant Professor of Anthropology; Ph.D., Stanford University, 1982.

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Assistant Professor of Education; Ed.D., Harvard University, 1974.

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Assistant Professor of English; B.A., University of New Hampshire, 1971.

**Wirth, Clifford J.** (1981)  
Assistant Professor of Political Science; Ph.D., Southern Illinois University at Carbondale, 1976.

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Assistant Professor of Chemistry; Ph.D., Harvard University, 1975.

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Associate Professor of Psychology; Ph.D., Yale University, 1975.

**Wright, John J.** (1970)  
Professor of Physics; Ph.D., University of New Hampshire, 1969.

**Wrightsman, Dwayne E.** (1964)  
Professor of Business and Economics; Ph.D., Michigan State University, 1964.

**Yildiz, Asim** (1967)  
Professor of Mechanics; D. Eng., Yale University, 1959.

**Yount, John A.** (1962-64, 1965)  
Professor of English; M.F.A., University of Iowa, 1962.

**Zsigray, Robert M.** (1970)  
Associate Professor of Microbiology and Genetics; Ph.D., Georgetown University, 1969.

# Committees of the Graduate School

## Committees of the Graduate School

### Graduate Council

**Raymond L. Erickson, Ph.D.**  
Dean of the Graduate School, Chairperson

**William H. Drew, Ph.D.**  
Associate Dean of the Graduate School

**Harry J. Richards, Ph.D.**  
Assistant Dean of the Graduate School,  
Secretary

**Charles H. Ashley, Ed.D.**  
Associate Professor of Education

**Richard W. England, Ph.D.**  
Associate Professor of Economics

**Albert D. Frost, Sc.D.**  
Professor of Electrical Engineering

**Francis R. Hall, Ph.D.**  
Professor of Hydrology

**Lyman Mower, Ph.D.**  
Professor of Physics

**Thomas G. Pistole, Ph.D.**  
Associate Professor of Microbiology

**Luke J. Rheaume**  
Ph.D. Student, Mathematics

**John E. Rogers, M.F.A.**  
Associate Professor of Music

**Rebecca M. Warner, Ph.D.**  
Assistant Professor of Psychology

**James H. Weber, Ph.D.**  
Professor of Chemistry

**Donald J. Wilcox, Ph.D.**  
Professor of History

Two graduate students will be appointed to the council  
in the fall.

### Research Council

**Lennard A. Fisk, Ph.D.**  
Director of Research

**Raymond L. Erickson, Ph.D.**  
Dean of the Graduate School

**Roger L. Arnoldy, Ph.D.**  
Professor of Physics

**Ginny W. Darr, Ph.D.**  
Assistant Professor of Animal Sciences

**George O. Estes, Ph.D.**  
Professor of Plant Science

**Robert Kertzer, Ph.D.**  
Associate Professor of Physical Education

**David E. Leary, Ph.D.**  
Associate Professor of Psychology

**Dean A. Morrow**  
Senior, Business Administration

**Sharon N. Oja, Ph.D.**  
Associate Professor of Education

**Charles K. Taft, Ph.D.**  
Professor of Mechanical Engineering

Two faculty members from Liberal Arts and one from  
the Whittemore School will be appointed in the fall.

One graduate student will be appointed in the fall.

### Student Fellowship Selection Committee

**William H. Drew, Ph.D.**  
Associate Dean of the Graduate School

**Richard P. Blakemore, Ph.D.**  
Associate Professor of Microbiology

**Wallace A. Bothner, Ph.D.**  
Professor of Geology

**Richard W. England, Ph.D.**  
Associate Professor of Economics

**Edmund F. Jansen, Jr., Ph.D.**  
Professor of Resource Economics

**Gary H. Lindberg, Ph.D.**  
Professor of English

### Faculty Fellowship Selection Committee

**William H. Drew, Ph.D.**  
Associate Dean of the Graduate School

**Paul L. Bishop, Ph.D.**  
Professor of Civil Engineering

**Richard W. Hurd, Ph.D.**  
Associate Professor of Economics

**Robert Kertzer, Ph.D.**  
Associate Professor of Physical Education

**John E. Limber, Ph.D.**  
Associate Professor of Psychology

**Lincoln C. Peirce, Ph.D.**  
Professor of Plant Science and Genetics

### Tuition Scholarship Selection Committee

**Harry J. Richards, Ph.D.**  
Assistant Dean of the Graduate School

**Lori A. Alexander, Ph.D.**  
Assistant Professor of Physical Education

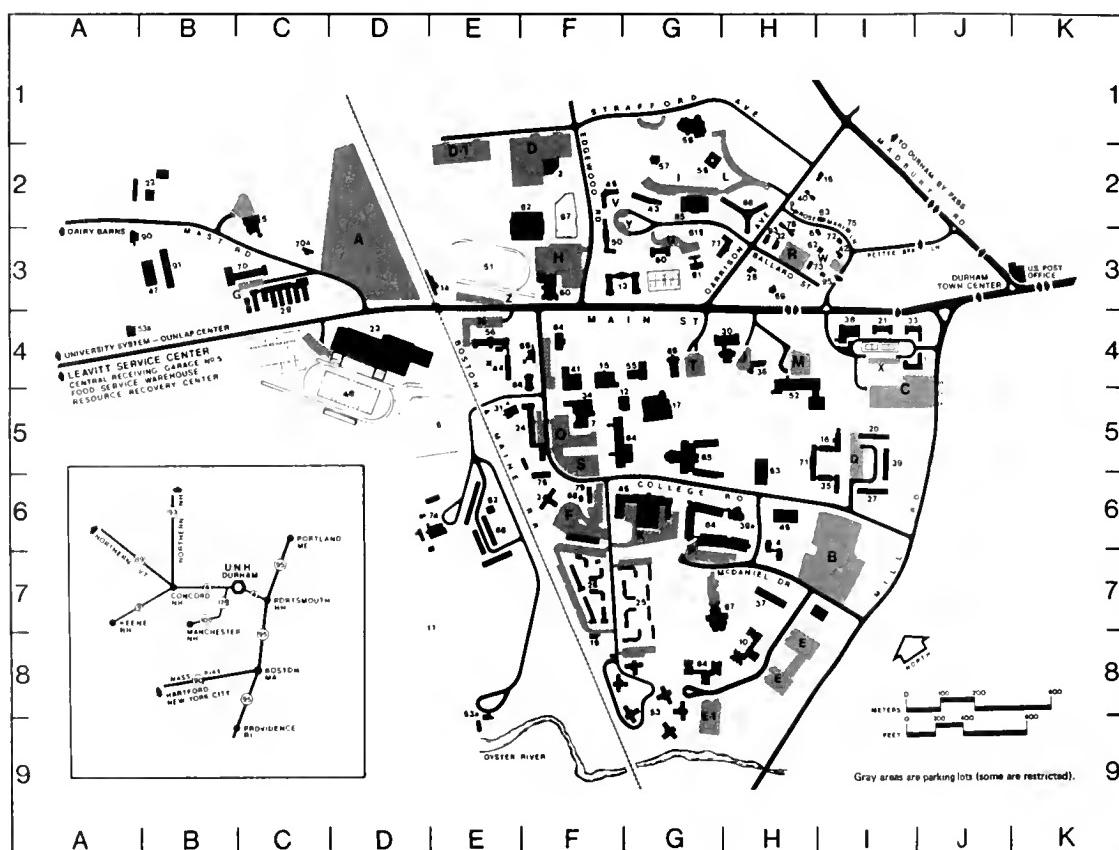
**Robert C. Gilmore, Ph.D.**  
Professor of History

**Richard Martin-Diaz, Ph.D.**  
Associate Professor of Administration

**Donald R. Miller, Ph.D.**  
Assistant Professor of Wildlife Ecology

**Samuel D. Shore, Ph.D.**  
Associate Professor of Mathematics

# Campus Map and Key



- Admissions Office (see 89)  
 Agricultural Experiment Station (see 88)  
 1 Alexander Hall J4  
 2 Alumni Center, John S. Elliott F2\*†  
 Archaeol. Teaching & Res. Lab (see 19)  
 3 Art Annex F6  
 4 Babcock House H6\*†  
 5 Barton Hall C2†  
 6 Batcheller House H3  
 7 Bookstore F5†  
 8 Brackett Field E5  
 9 Brook House H2  
 10 Christensen Hall H8\*†  
 11 College Woods E7  
 Computer Center (see 45)  
 12 Conant Hall G5  
 13 Congreve Hall F3  
 Cooperative Extension Service (see 88)  
 Counseling and Testing Center (see 78)  
 14 Dairy Bar E3  
 15 DeMeritt Hall F4†\*  
 16 Devine Hall I5†\*  
 17 Dimond Library G5\*  
 18 DeMeritt House, Elizabeth I2\*  
 Eaton House (see 53)  
 Elliott Alumni Center (see 2)\*†  
 19 Archaeol. Teaching & Res. Lab F8  
 Engineering and Physical Sciences,  
     College of (see 45)  
 Engineering Design & Anal. Lab (see 45)  
 20 Englehardt Hall I5  
 Faculty Center (see 28)
- 21 Fairchild Hall I4  
 22 Farm Service Buildings B2  
 23 Field House D4†  
 Financial Aid (see 89)  
 24 Fire Station and Service Building F5†  
 25 Forest Park Apartments I G7  
 26 Forest Park Apartments II F7‡  
 27 Gibbs Hall I6  
 Graduate School (see 83)  
 28 Grant House H3  
 29 Greenhouses and Pesticide Lab C3  
 Hall House (see 53)  
 30 Hamilton Smith Hall H4†  
 Health Services (see 36)  
 Health Studies, School of (see 34)  
 31 Heating Plant E5  
 32 Hersey House H3  
 33 Hetzel Hall I4  
 34 Hewitt Hall F5†  
 35 Hitchcock Hall I6  
 36 Hood House H4†\*  
 Horton Social Science Center (see 83)\*†  
 37 Hubbard Hall H7  
 38 Huddleston Hall I4†  
 39 Hunter Hall I5†  
 39a Iddles Auditorium H6†  
 Instrumentation Center (see 45)  
 40 Petree House H2  
 41 James Hall F4\*†  
 42 Janetos House I3  
 43 Jessie Doe Hall G2  
 44 Kendall Hall E4†\*

- 45 Kingsbury Hall†\* and Marine Programs Building **G6**  
 46 Lewis Field **D5**  
 Liberal Arts. College of (see 55)  
 Life Sciences and Agriculture, College of (see 88)  
 47 Livestock Activities Center **B3**  
 48 Lord Hall **F2**  
 Marine Programs (see 45)  
 Marston House (see 53)  
 49 McConnell Hall **H6\*†**  
 50 McLaughlin Hall **F3**  
 Mechanics Research Lab (see 45)  
 51 Memorial Field **E3**  
 52 Memorial Union Building **H5†\***  
 53 Mini Dorms (Eaton, Hall, Marston, Richardson, Sackett, Woodruff) **G8**  
 53a Moiles House (4-H) **A4**  
 54 Morrill Hall **F4\*†**  
 55 Murkland Hall **G4†**  
 Natural and Environmental Resources, Institute of (see 41)  
 56 Nesmith Hall **E4**  
 New England Center:  
 57 Adams Residential Tower **G2\***  
 58 Administration Building **G2**  
 59 Kellogg Learning Center **G1\*†**  
 60 New Hampshire Hall **F3†**  
 61 Nursery School **G3**  
 62 O'Connell House **H3**  
 63 Palmer House **I2**  
 Parking lots—gray areas  
 64 Parsons Hall **G6†\***  
 65 Paul Creative Arts Center **G5†**  
 66 Pettee Hall **E4**  
 Pettee House (see 40)  
 67 Philbrook Dining Hall **H7†**  
 68 Poultry Plant **E6**  
 69 President's House **H3**  
 Public Administration Service (see 83)  
 70 Putnam Hall **C3**  
 70a Racing Commission Stables **C3†**  
 71 Randall Hall **H5**  
 Registrar (see 89)  
 Residence Office, housing (see 40)  
 Resources Development Center (see 95)
- 72 Rice House **I3**  
 73 Richards House **H3**  
 Richardson House (see 53)  
 74 Ritzman Nutrition Laboratory **E6**  
 75 Robinson House **I2**  
 76 ROTC Building, Zais Hall **F6†**  
 Sackett House (see 53)  
 77 Sawyer Hall **G3**  
 78 Schofield House **H2**  
 79 SCORE Building **F6**  
 80 Scott Hall **G3**  
 Service Building (see 24)†  
 81 Smith Hall **G3**  
 82 Snively Arena **F2†**  
 83 Social Science Center, Horton **H5\*†**  
 84 Spaulding Life Science Center **G5†**  
 85 Stillings Dining Hall **G2**  
 86 Stoke Hall **H2\***  
 Student Affairs (see 38)  
 87 Swimming Pool, outdoor **F2**  
 88 Taylor Hall **F4†**  
 Theaters (see 65)  
 89 Thompson Hall **G4\*†**  
 Thompson School of Applied Science (see 5)  
 Tickets, athletic (see 23)  
 Tickets, cultural events (see 52)  
 90 Tirrell Classroom Building **B3**  
 91 Tirrell Light Horse Stable **B3†**  
 92 Tumor Research Building **E6**  
 93 Verrette House **H3†**  
 Water Resources Res. Cntr. (see 66)  
 93a Water Treatment Plant **E8**  
 WENH-TV (see 52)  
 Whittemore School of Business and Economics (see 49)†\*  
 94 Williamson Hall **G8\*†**  
 95 Wolff House **I3**  
 Woodruff House (see 53)  
 Zais Hall (see 76)†

\* building equipped with elevator

† building accessible at ground level

‡ one apt. only is accessible

# **Graduate School Calendar 1982–83**

## **Semester I**

September 8, Wednesday	8 a.m. Classes begin
September 13, Monday	Graduate student registration (day students)
September 13–16, Mon–Thurs	Graduate student registration (evening students, 5–7 p.m.)
September 17, Friday	Last day to drop courses without \$10 late-drop fee Last day to request audit without dean's approval
September 20, Monday	Last day to withdraw and qualify for $\frac{3}{4}$ tuition refund
September 24, Friday	Last day to file Intent to Graduate for December graduation Last day to add courses without dean's approval and \$10 late-add fee
October 7, Thursday	Last day to withdraw and qualify for $\frac{1}{2}$ tuition refund
October 29, Friday	Midsemester—Last day to drop courses or withdraw without academic liability; last day to carry more than 16 credits without surcharge
November 11, Thursday	Veterans Day holiday—no classes
November 19, Friday	Last day for Ph.D. dissertation defense (December graduation)
November 24, Wednesday	Classes hold Thursday schedule
November 25–26, Thurs–Fri	Thanksgiving holiday—no classes
November 29, Monday	8 a.m. Classes resume
December 1, Wednesday	Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Spring Semester, 1983
December 3, Friday	Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (December graduation) Last day to take final comprehensive examination for the master's degree
December 17, Friday	Last day for resolving incompletes from Semester II 1981–82 and/or Summer 1982
December 18, Saturday	Commencement Reading Day
December 20, Monday	Semester I final exams begin
December 23, Thursday	Final exams end

## **Semester II**

January 26, Wednesday	8 a.m. Classes begin
January 31, Monday	Graduate student registration (day students)
January 31–February 3, Mon–Thurs	Graduate student registration (evening students, 5–7 p.m.)
February 4, Friday	Last day to drop courses without \$10 late-drop fee Last day to register for audit without dean's approval

February 7, Monday	Last day to withdraw and qualify for $\frac{3}{4}$ tuition refund
February 11, Friday	Last day to add courses without dean's approval and \$10 late-add fee
February 15, Tuesday	Last day for completing application for admission to graduate study for Fall Semester 1983, to insure consideration for financial assistance for the 1983-84 academic year
February 24, Thursday	Last day to withdraw and qualify for $\frac{1}{2}$ tuition refund
February 25, Friday	Last day to file Intent to Graduate for May graduation
March 21-25, Mon-Fri	Spring Recess
March 28, Monday	8 a.m. Classes resume
April 1, Friday	Midsemester—Last day to drop courses or withdraw without academic liability; last day to carry more than 16 credits without surcharge
	Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session, 1983
April 29, Friday	Last day for final Ph.D. dissertation defense (May graduation)
May 13, Friday	Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (May graduation)
	Last day to take final comprehensive examination for the master's degree
May 17, Tuesday	Last day for resolving incompletes from Semester I 1982-83
May 18-19, Wed-Thurs	Reading days
May 20, Friday	Semester II final exams begin
May 26, Thursday	Final exams end
May 28, Saturday	Commencement

## Summer Session 1983

June 3, Friday	Last day to file Intent to Graduate for September graduation
July 1, Friday	Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Fall Semester, 1983.
July 22, Friday	Last day for final Ph.D. dissertation defense (September graduation)
August 5, Friday	Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (September graduation)

**The University reserves the right to modify the calendar subsequent to printing.**

# Index

- A**bbreviations 27  
Academic regulations 21–25  
Administrative withdrawal 16  
Admission 12–14  
Agricultural Experiment Station 10  
Alumni Association 9  
Animal Sciences 28, 72  
Application 12  
Applied Music 92  
Assistantships 19  
Associates 20
- B**abcock House 7  
Biochemistry 29  
Biology 30  
Botany and Plant Pathology 31  
Business Administration 33
- C**alendar 128  
Campus 2, 5, 6, 126  
Career Planning and Placement 8  
Certificate for Advanced Graduate Study 24, 54  
Chemical Engineering 6, 36  
Chemistry 37  
Churches 9  
Civil Engineering 6, 40  
Committees of the Graduate School 125  
Communication Disorders 43  
Computer Center 10  
Computer Engineering 6, 60  
Computer Science 44  
Computer Services 11  
Conditional Admission 14  
Continuing education 9, 24  
Counseling and Testing Center 38  
Course charges 18  
Course descriptions 27–112  
Credits 22–24  
Cultural activities 6
- D**eadlines 12  
Degree candidacy 24  
Degree programs 3  
Departmental requirements 27–112  
Diamond Island Ocean Engineering Station 11  
Dining 7  
Dissertation 25  
Division of Continuing Education 5, 15  
Doctoral programs 3, 6, 24  
Doctor of Philosophy 3, 6, 24  
*See also specific departments*
- E**arth Sciences 46  
Economics 49  
Ecumenical ministry 9  
Education 51  
Electrical and Computer Engineering 6, 60  
Employees, University 14  
Engineering Ph.D. Program 6, 64  
English 65  
Entomology 70  
Environmental Resources, Institute of Natural and 6, 72, 78, 79  
Examinations 23, 24
- F**acilities 10  
Faculty 114–124  
Family Research Laboratory 10  
Fees 17, 18  
Fellowships 19  
Financial Aid 19  
Foreign students 12  
Forest Park 7
- Forest Resources 73, 80
- G**enetics 6, 71, 99  
Genetics Program 6, 71  
Geology 46  
Grades 21  
Graduate Council 6, 125  
Graduate School Office 6
- H**andicapped Student Services 9  
Health services 8  
History 73  
Home Economics 76  
Honorary fellows 14  
Hood House 8  
Housing 7  
Hydrology 81
- I**ncompletes 21  
Institute of Natural and Environmental Resources 6, 72, 78, 79  
Instrumentation Center 10  
Insurance 8  
Intercollege Biological Sciences Organization 6, 30  
Intercollege Course 82  
Interdisciplinary programs 6, 10, 64, 71, 78  
Interlibrary loan 11
- J**Jackson Estuarine Laboratory 10, 11
- L**Leave of absence 15  
Library 11  
Loans 20
- M**ap 2, 126  
Marine Program 10, 11  
Marine science 10  
Married students' housing 7  
Master of Business Administration 33  
Master of Arts 3, 5  
*See also specific departments*  
Master of Arts in Teaching 53  
Master of Education 51, 53  
Master of Occupational Education 94  
Master of Public Administration 100  
Master of Science 3, 5  
*See also specific departments*  
Master of Science for Teachers 3, 5, 12  
*See also specific departments*  
Master's programs 3, 5, 23  
*See also specific departments*  
Master's requirements 23  
Master's thesis 23  
Mathematics 82  
Mechanical Engineering 6, 86  
Media Services 11  
Memorial Union 6  
Merit, Graduate Scholarships for 19  
Merrimack Valley College 5  
Microbiology 73, 89  
Ministry 9  
Music 91  
Music, applied 92  
Music Education 91, 93
- N**Natural and Environmental Resources 6, 72, 78, 79  
New England Regional Program 17  
New England Center for Continuing Education 9

**O**ccupational Education 4  
Ocean Engineering 10, 11  
Oceanography 10, 46  
Off-campus courses 22  
Off-campus housing 7  
Officers of administration 113

**P**h.D. requirements 24  
Physical Education 95  
Physics 96  
Placement service 8  
Plant Science 73, 98  
Political Science 100  
Psychology 102

**R**ecreation 6  
Refund of course charges 18  
Registration 14  
Regulations, academic 21  
Requirements, departmental 27–112  
Requirements, doctor's degree 24  
Requirements, master's degrees 23  
Research 10  
Research Computing Group 11  
Research Council 6, 125  
Residences 7  
Resident, nonresident status 17  
Resource Economics 81  
Ritzman Animal Nutrition Laboratory 10

**S**cholarships 19  
Sea Grant 10, 11  
Senate, University 6  
Senior, University 14  
Service facilities 10  
Shoals Marine Laboratory 10, 11  
Social activities 6  
Social Psychology 103  
Sociology 104  
Soil Science 82  
Space Science Center 10  
Spanish 108  
Special students 14  
Stipends 19–20  
Student life 6–9  
Student services 8, 9  
Sub-Degree Exchange Program 17  
Summer Assistantships and Fellowships 19, 20  
Summer Housing 7  
Summer Session 15

**T**eaching and Learning Council 6  
Testing 8  
Thesis 23  
Thesis fees 18  
Transfer of credits 22  
Trustees 113  
Tuition 18

**U**nion, student 6  
University Instrumentation Center 10  
University System of New Hampshire 5

**W**ithdrawal 15  
Work-Study 20  
Writing, Master of Arts in 66

**Z**oology 7, 73, 109



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